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Acid Rain Research Inventory FY 79-80

MITRE Corp.
McLean, VA

Prepared for

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Washington, DC

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The inventory contains a description of EPA funded acid rain research projects in FY 79 and FY 80. The projects listed are either being performed internally by EPA laboratories or contracted out to other government laboratories, universities, private industries, etc. This is the first attempt at assembling EPA's acid rain funded projects. Some of the summaries are slightly incomplete and it is possible that a few projects have been overlooked. In addition, projects less than $5K have been eliminated from this summary.

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Acid Rain Research Inventory FY 79-80

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Acid Rain Research Inventory
FY 79-80

Edited By
David A. Bennett
Office of Exploratory Research
(RD-675)

September 1980

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The MITRE Corporation under Contract No. 68-02-5051

Office of Research and Development
U.S. Environmental Protection Agency
Washington, D.C. 20460

Foreword

Acid rain is a major environmental problem on both sides of the Atlantic Ocean. Originally noticed and studied in the Scandinavian countries and in Canada, acid rain has been documented in this country, first in the Northeast and now throughout much of the United States east of the Mississippi River. Acid rain has continued to spread in both severity and aerial extent in the eastern United States. In the mid-1950s, the pH of rainwater in a large portion of the eastern United States was less than the "natural" atmospheric value of 5.6, with the zone of greatest acidity (pH 4.5) located in and to the east of the area where sulfur dioxide emissions were highest: parts of Ohio, Pennsylvania, West Virginia, New York, and New England. By the early 1970s, the area with an average pH below 4.5 had extended to include most of the continental area east of the Mississippi River. Long-term monitoring networks are currently being established across the U.S. to assess more definitively the spread of the acid rain phenomenon.

Acid rain originates from industrial and transportation sources releasing sulfur oxides (SO_x) and nitrogen oxides (NO_x) into the atmosphere. These constituents are transformed into sulfuric acid (H_2SO_4) and nitric acid (HNO_3), respectively, through a process known as oxidation. The sulfates and nitrates are transported and eventually removed from the atmosphere and deposited on vegetation, soils, surface waters, and materials.

A growing body of evidence suggests that acid rain may have substantial adverse effects on the environment. Such effects may include acidification and mobilization of heavy metals in lakes, rivers, and groundwaters, with resultant damage to fish and other components of aquatic ecosystems; acidification and demineralization of soils; reduction of forest productivity; damage to crops; and deterioration of man-made materials. These effects may be cumulative or may result from peak acidity episodes. Continued study of all potentially impacted systems is required.

Existing environmental regulations do not directly address the acid rain problem. However, in recognition of the potential seriousness of the acid rain problem, President Carter in his Second Environmental Message to Congress in August of 1979 called for an extensive research program to be conducted over the next ten years. This program is coordinated by the Federal Acid Rain Coordination Committee, cochaired by the Environmental Protection Agency and the Department of Agriculture with the Council on Environmental Quality serving as executive secretary.

EPA's research activities specifically targeted at acid rain began late in the 1970s. By FY 1979, acid rain monitoring and research in atmospheric processes and environmental effects were funded just slightly under the $4 million mark. Funding in FY 1980 is approximately $5.5 million.

The report that follows summarizes research supported by EPA's Office of Research and Development during FY 1979-1980 to determine the nature and magnitude of the acid rain problem.

Dennis A. Tirpak
Acting Director
Office of Exploratory Research

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Abstract

This document contains a description of each of the EPA projects being funded in the acid rain area. The projects listed are either being performed internally by EPA laboratories or contracted out to other government laboratories, universities, private industries, etc. This is the first attempt at assembling EPA's acid rain funded projects. Some of the summaries are slightly incomplete and it is possible that a few projects have been overlooked. In addition, projects less than $5K have been elimated from this summary.

Introduction

Acid rain research projects funded by EPA address virtually all of the areas of concern in the acid rain problem from sources to the effects upon the ultimate receptors. These projects are performed either internally by EPA laboratories or under contract to other governmental laboratories, academic institutions, and other contractors.

The following is an inventory of acid rain research projects funded at a level of $5K or more by EPA's Office of Research and Development in FY 79 or FY 80, through June 1, 1980. Several additional projects will be funded during the last quarter of FY 80. Provided for each inventoried project are research objectives, funding summary, project description, principal project personnel and planned reports.

Projects are grouped by their research objectives in the following manner:

Section I : Environmental Effects and Economics
Section II : Monitoring and Quality Assurance
Section III: Atmospheric Processes
Section IV : Program Support.

Each project has an identifying code for its classification in the subject and performing institution indices at the rear of the inventory.

EPA has published a number of documents to give both the layman and the technically trained descriptions of the acid rain problem and EPA's research program. Reports and/or publications that have recently been published or are about to be released include:

- Research Summary: Acid Rain. October 1979. EPA-600/8-79-028. A summary of EPA's acid rain research program.
- Acid Rain and the Environment. August 1980. EPA-600/9-79-036. An in-depth discussion of the global acid rain problem focusing on the latest environmental effects data being developed in North America and Scandinavia.
- Research Summary: Controlling Nitrogen Oxides. February 1980. EPA-600/8-80-004. A summary of EPA's research concerning NO_x emissions and their contribution to the acid rain problem.
- Research Highlights, 1979. January 1980. EPA-600/9-80-005. 100 pages. Highlights of the EPA research program accomplishments of 1980.
- Research Outlook 1980, February 1980. EPA-600/9-80-006. 224 pages. A concise description of the EPA's plans for future environmental research.

These publications and other technical reports may be obtained by writing to:

Center for Environmental Research Information
26 West St. Clair Street
Cincinnati, OH 45268.

Project Title:
Research on the Effect of Acid Precipitation on Aquatic and Terrestrial Ecosystems (NCSU Cooperative Agreement No. 806192)

Code:
EE 1.0

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
500K	648K

EPA Project Officer:
Norman Glass
Environmental Research Laboratory
200 S.W. 35th St.
Corvallis, OR 97330
(503) 759-4671

Principal Investigator:
Ellis Cowling
Department of Plant Pathology
School of Forest Resources
North Carolina State University
Raleigh, NC 27650
(919) 737-2883

Objectives and Approach

Through Cooperative Agreement No. 806192, North Carolina State University will coordinate, manage and conduct (largely through subcontracting to scientists at appropriate educational and research institutions) research on environmental effects of acid precipitation. The objectives are to:

- Determine the geographic distribution of sensitive aquatic and terrestrial ecosystems and those exhibiting symptoms of damage, and identify current extent of damage.
- Determine actual and potential effects on terrestrial and aquatic components of lake-watershed ecosystems, and develop models linking ecological response to acid precipitation inputs;
- Determine effects on native and commercial vegetation.

Research proposals from the scientific community at large have been evaluated by the governing board and the steering committee. Research funded in FY 79 and FY 80 is as follows:

Aquatic:

- Heavy Metal Exchange Between Sediments and Overlying Water and Diatom Community Response in Lake Microcosms Subjected to Increased H^+, Pb, and Zn Loading. (FY 79)
- The Effects of Acidification on Processing of Organic Matter in Streams. (FY 79)
- Whole Ecosystem Experiments to Test the Effects of Acid Precipitation on North American Freshwater Lakes. (FY 80)
- Effects of Acidification on Soft-Water Lakes in Florida. (FY 80)
- Henriksen's Empirical Model for Lake Acidification: Can It Be Used for Prognosis? (FY 80)

Terrestrial:

- Effects of Acid Precipitation on Reproduction of Fruit Crops. (FY 79)
- Effects of Simulated Acid Precipitation on Field Crops and Fusiform Rust of Loblolly Pine. (FY 79 and FY 80)
- Effects of Acid Precipitation on Decomposition and Weathering Processes in Terrestrial Ecosystems. (FY 79 and FY 80)
- Effects of Changing Patterns of Acidic Precipitation on the Quality and Yield of Major Agricultural Crops of the Northeastern U.S. (FY 79 and FY 80)
- Effects of Acid Precipitation on Microbial Mineralization of Nitrogen in Soil. (FY 80)
- Effects of Acid Precipitation on Microbial Transformations in Soil and Resulting Nutrient Availability in Plants. (FY 80)
- Effects of Acid Precipitation on Sandhill Soils of the Southeastern United States. (FY 80)

Synthesis and Integration:
Assessment and Synthesis of Research Related to Biological Effects of Acid Deposition.

Expected Output:

Final and annual reports.

Milestones/Delivery Dates:

Determined for each project.

NCSU Cooperative Agreement Funded Projects

The previous page summarized the NCSU Cooperative Agreement (No. 806192). The next section will detail the projects that have been funded under this mechanism.

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NCSU Cooperative Agreement Funded Projects

The previous pages summarized the NCSU Cooperative Agreement (No. 806192). The next section will detail the projects that have been funded under this mechanism.

Project Title:
Effects of Simulated Acid Precipitation on Field Crops and Fusiform Rust of Loblolly Pine

Code:
EE 1.1

Period of Performance/Funding:

FY 79	FY 80
15K	15K

Principal Investigator:
Allen Heagle
USDA-SEAS
Plant Pathology Department
North Carolina State University
Raleigh, NC 27650

Objectives and Approach:

Determine short- and long-term effects of simulated acidic 'rain' on injury, growth and yield of soybeans and corn under field conditions. Measure changes in chemical, physical and biological soil factors that can affect crop productivity. Determine threshold doses of acidic 'rain' on the epidemiology of fusiform rust of loblolly pine.

Existing facilities for dispensing simulated 'rain' will be used. Crop plants will be grown in 24 3-m^2 plots (six blocks of four plots each) and exposed to 'rain' at four pH values (5.7, 4.0, 3.2 and 2.8). Potted loblolly pine will be exposed to four pH levels before, during, and after inoculation with fusiform rust in an adjacent dispensing facility. *In vitro* studies with aeciospores and basidiospores will also be performed.

Project Title:
Effects of Changing Patterns of Acidic Precipitation on the Quality and Yield of Major Agricultural Crops of the Northeastern U.S.

Code:
EE 1.2

Period of Performance/Funding:

FY 79	FY 80
40K	49K

Principal Investigator:
Jay Jacobson
Boyce Thompson Institute
Cornell University
Ithaca, NY 14853

Objectives and Approach:

This experimental investigation is designed to supplement a research program that has been functioning since 1973. It provides for the development and application of techniques for the field exposure of crops to simulated rain that closely simulates actual conditions. Furthermore, this proposal emphasizes the possible benefits and costs to agriculture of reductions and increases in deposition of components of rain, whereas the existing program emphasizes the effects of current levels of acidity, sulfate, and nitrate concentrations. Economically important field and vegetable crops of the eastern U.S. will be exposed to rain of differing hydrogen, sulfate, and nitrate ion composition using patterns, intensities, durations, and frequencies that imitate ambient conditions. Data on rain chemistry obtained from the NADP network will be used to design these experiments.

Project Title:
Assessment and Synthesis
of Research Related to Biological Effects
of Acid Deposition

Code:
EE 1.3

Period of Performance/Funding:

FY 79	FY 80
68K	-0-

Principal Investigator:
Orie Loucks
The Institute of Ecology
Butler University
Indianapolis, IN 46208

Objectives and Approach:

(1) To carry out reviews and assessments of the scientific results from various programs on acid deposition so as to achieve optimal use of results for EPA; and (2) to conduct workshops on geographically focused, issues-focused, or policy questions so as to summarize research, identify gaps and develop consensus in a national acid rain effects program. Three initiatives will be undertaken: (1) a continuing review of relevant data bases and models (using small workshops as needed) so as to evaluate response simulations and propose options for meeting regulatory needs; (2) begin comparative studies of regulatory and ameliorative approaches to the adverse effects of acid deposition and arrange a conference entitled "Management Options for Controlling Acid Deposition"; and (3) improve on the quantitative methods for assessing long-term effects on regional ecosystems through use of watershed nutrient-flux simulation models.

Project Title:
Effects of Acid Precipitation
on Reproduction of Fruit Crops

Code:
EE 1.4

Period of Performance/Funding:

FY 79	FY 80
50K	-0-

Principal Investigator:
Robert Musselman
Department of Pomology and Viticulture
NY State Agricultural Experiment Station
Geneva, NY 14456

Objectives and Approach:

Reproduction in fruit crops consists of a two-year cycle. Each stage of the cycle is important in maintaining productivity and marketability of the fruit crop which results from this cycle. One of the most critical stages of the two-year reproductive cycle is flowering or bloom, seldom exceeding one week in duration. The objective of this study is to determine the effects of acid precipitation on this critical reproductive stage of fruit plants.

The experimental approach will be to treat field-growing apple trees and grapevines with simulated acid precipitation at various pH levels at various stages of fruit bloom. Field studies will be supported with laboratory tests on potted fruit plants.

Project Title:
Heavy Metal Exchange Between Sediments and Overlying Water and Diatom Community Response in Lake Microcosms Subjected to Increased H^+, Pb, and Zn Loading

Code:
EE 1.5

Period of Performance/Funding:

FY 79	FY 80
54K	-0-

Principal Investigator:
Stephen Norton
Ronald Davis
110 Boardman Hall
University of Maine
Orono, ME 04469

Objectives and Approach:

Investigate the dynamic exchange of metals between the lake water column and sediment as a function of pH and the chemical activity of the metals (at least Pb and Zn); study the state of the metals in the sediment (adsorbed, precipitated, in organic matter, etc.); and study the responses of periphytic diatom communities to these changes in pH and metal levels.

Project Title:
Acid Rain and Material Damage on Stone

Code:
EE 1.6

Period of Performance/Funding:

FY 79	FY 80
30K	35K*

Principal Investigator:
Norbert Baer
Conservation Center
New York University
One East 78th Street
New York, NY 10021

Objectives and Approach:

The many variables associated with material damage of stone place a severe burden on the evaluation of field data and correlation with atmospheric pollutant levels. The ideal subjects for analysis should be uniform materials; controlled production conditions; placement in a variety of climates and environments; placement over a continuous and extended time sequence; sensitivity to environmental pollutants; and accessible, high quality documentation. All of these conditions are met by the marble headstones and markers placed under the direction of what is now the Headstone Service of the Veterans Administration. Clearly, the headstones and markers placed by the Headstone Service of the National Cemetery System also represent an ideal universe for the correlation of atmospheric pollutant levels with materials' decay. Four geographic regions for initial study were selected: Appalachian, Far West, Northeast, and Southeast Coast. Initial review of these areas suggests 16 national cemeteries to study. In the initial phase of the project, these areas and national cemeteries will be reviewed for suitability depending on such factors as availability of environmental data, uniformity of materials for markers, and unusual historical factors, for example, excessive recent replacement and/or unusual local marker treatment methods. Each marker added to the data base will be examined for measurable loss of detail, rounding of edges, erosion of surface, etc., to develop quantitative estimates of damage. Documentation will include identification of the individual marker to permit evaluation of its history as recorded in Veterans Administration records. Air pollution, acid rain, and meteorological data will be obtained from EPA and National Weather Service records.

All identifiable variables will be recorded to permit the extraction of the maximum usable data from the experiment. The large amount of data collected in this study will also enable corrections to be made for other variables, such as rainfall, humidity, freeze fall cycles, etc. Statistical analyses of these unique data will permit a correlation between geographical location and relative rates of material damage.

* Second year funding of 35K through Environmental Sciences Research Laboratory.

Project Title:
The Effects of Acidification on Processing of Organic Matter in Streams

Code:
EE 1.7

Period of Performance/Funding

FY 79	FY 80
59.2K	-0-

Principal Investigator:
Thomas Burton
Institute of Water Research
Michigan State University
East Lansing, MI 48824

Objectives and Approach:

The objectives of this study are to quantify changes in (1) processing rates of organic matter by the biota in soft-water streams as a consequence of acidification of such streams, (2) species composition and growth rates of stream invertebrates resulting from acidification, and (3) stream chemistry associated with acidification. The experimental approach involves using two 12-m long x 1.5-m wide recirculating artificial channels to simulate a soft-water stream in northern Michigan. One channel will be operated at present background pH levels and the other will be acidified.

Project Title:
Effects of Acid Precipitation on Decomposition and Weathering Processes in Terrestrial Ecosystems

Code:
EE 1.8

Period of Performance/Funding:

FY 79	FY 80
30K	50K

Principal Investigator:
Christopher S. Cronan
Department of Biological Sciences
Dartmouth College
Hanover, NH 03755

Objectives and Approach:

Objectives:
1) To conduct lysimeter microcosm studies for evaluating the effects of acid precipitation on soil weathering and organic matter decomposition processes, and 2) to develop further predictive understanding regarding the comparative effects of acid precipitation on nutrient depletion and nutrient replenishment processes in terrestrial ecosystems.

Approach:
Laboratory microcosm studies closely tied to key field sites and ongoing field research.

Project Title:
The Effect of Acid Precipitation on Microbial Mineralization of Nitrogen in Soil

Code:
EE 1.9

Period of Performance/Funding:

FY 79	FY 80
-0-	32.8K

Principal Investigator:
Martin Alexander
Department of Agronomy
Cornell University
Ithaca, NY 14853

Objectives and Approach:

- To determine the effect of acid precipitation on mineralization of nitrogen and nitrification as affected by soil depth.
- To determine the influence of plant roots in modifying the effect of acid precipitation on nitrogen mineralization and nitrification.
- To establish whether adaptation occurs among microorganisms to make the nitrogen mineralizing and nitrifying populations more able to cope with stresses associated with acid precipitation.

Project Title:
Effects of Acid Precipitation on Microbial Transformations in Soil and Resulting Nutrient Availability in Plants

Code:
EE 1.10

Period of Performance/Funding:

FY 79	FY 80
-0-	25K

Principal Investigator:
John G. McColl
Department of Soils and Plant Nutrition
University of California
Berkeley, CA 94720

Objectives and Approach:

To determine effects of acid precipitation on the microbial transformation and availability of nutrients in soils by examining key reactions of the nitrogen cycle in rhizosphere and nonrhizosphere soil. Soil samples will be those from a greenhouse experiment in which plants (N-fixing and non-N-fixing) will be grown in two soil types, and to which various "acid rain" treatments will be imposed. Microbial activity for nitrification, denitrification and nitrogen-fixation processes will be determined for rhizosphere and nonrhizosphere soil.

Project Title:
Effects of Acid Precipitation on Sandhill Soils of the Southeastern United States

Code:
EE 1.11

Period of Performance/Funding:

FY79	FY 80
-0-	40K

Principal Investigator:
Robert Volk
Soil Science Department
University of Florida
Gainesville, FL 32611

Objectives and Approach:

The proposed research will examine the effects of acid rain on (1) the chemical properties of soils; (2) organic matter and forest litter decomposition; (3) nitrogen transformation; and (4) soil microbial populations.

In field and laboratory studies, soils will be leached with "normal" and acid rain. Complete elemental analysis, organic matter contents, soluble carbon, and cation exchange capacities will be determined. Changes in organic matter decomposition rates and lignin-cellulose levels will be monitored. Nitrogen transformation studies and microbial populations will be examined in field and laboratory experiments before and after acid treatments.

Project Title:
Whole Ecosystem Experiments to Test the Effects of Acid Precipitation on North American Freshwater Lakes

Code:
EE 1.12

Period of Performance/Funding:

FY 79	FY 80
-0-	112K

Principal Investigator:
David Schindler
Freshwater Institute
Winnipeg, Manitoba, Canada

Objectives and Approach:

Several lakes of the Experimental Lakes Area in Ontario will be artificially acidified to establish and/or evaluate:

- Chemical budgets, including input-output budgets for sulfate, nitrate, H^+, and alkalinity; noncarbonate bufferings; heavy metals.
- The oligotrophication hypothesis, including effect of acidification on lake respiration and primary production; analysis of phosphorus budget; nutrient cycling; comparison of effects of sulfuric and nitric acids.
- Biotic responses to acidification, including changes in species composition; toxicological or physiological tests; effects on fish; moulting and calcium metabolism in crayfish and other invertebrates.
- Changes in organic matter decomposition.

Project Title:
Effects of Acidification
on Soft-Water Lakes in Florida

Code:
EE 1.13

Period of Performance/Funding:

FY 79	FY 80
-0-	31.2K

Principal Investigator:
Patrick L. Brezonik
Department of Environmental
Engineering Sciences
University of Florida
Gainesville, FL 32611

Objectives and Approach:

This study is part of a long-range effort to determine effects of acid rain on the productivity and cycling of minerals and nutrients in Florida's poorly buffered lakes and watersheds. The lakes will be studied during 1980 in the first phase of a watershed study. Experiments will be conducted on four subobjectives: (1) causes of decreased primary productivity in lakes with decreasing pH; (2) effects of pH on N and P mineralization rates; (3) effects of acidification on Al levels and speciation in lake waters, and the toxicity of Al and H^+ to native fish species; and (4) delineation of historical trends of acidification in area lakes by analysis of short sediment cores. Efforts will be made to separate the effects of acidification from the effects of nutrient loadings on changes in primary production. Lab and field experiments will examine effects of pH on nutrient regeneration by microorganisms and invertebrate fauna. Short-term bioassays will be conducted on largemouth bass and bluegills to determine toxic levels of Al and H^+ singly and in combination.

Project Title:
Henriksen's Empirical Model
for Lake Acidification:
Can It Be Used for Prognosis?

Code:
EE 1.14

Period of Performance/Funding:

FY 79	FY 80
-0-	40K

Principal Investigator:
A. Henriksen and R. F. Wright
Norwegian Institute for Water Research
Oslo, Norway

Objectives and Approach:

Henriksen's model for lake acidification uses the pH and calcium content of lake water to separate lakes into bicarbonate, transition, and acid lake groups. It now remains to be shown whether the model can predict the response of lakes to increased or decreased atmospheric acid loading. This will be tested using existing water quality and precipitation data.

Project Title:
Short-Term Research Program on Environmental Effects of Acid Rain

Code:
EE 2

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
115K	-0-

EPA Project Officer:
Norman Glass
Environmental Research Laboratory
200 S.W. 35th Street
Corvallis, OR 97330
(503) 757-4671

Principal Investigators:
Seven principal investigators were involved with this study.

Research Objectives and Project Description:

Although the acidity of precipitation has been demonstrated to be increasing over large areas of the United States, there is little information, when considering the problem on a regional basis, on the extent of the impact on the vast majority of aquatic or terrestrial ecosystems. As a first step in gaining some understanding of the potential for short-term and long-term effects which may be expected, a series of studies were instituted to determine sensitive areas in the eastern United States and to attempt to scale these according to their vulnerability. These studies, for the most part, made use of currently available information.

The studies comprising the short-term program were as follows:

- Geological and hydrochemical sensitivity of the eastern United States to acid precipitation. Brookhaven National Laboratory. $61,000.
- Sensitivity of soil regions to acid precipitation. Purdue University. $10,000.
- Computer calculation of the effect of acid precipitation on soil leachate quality. University of California—Riverside. $5,000.
- Probable effects of acid precipitation on Pennsylvania waters. Pennsylvania State University. $7,000.
- Potential impacts of acid precipitation on agriculture and forestry. Oregon State University. $10,000.
- Identification and location of potential ecological research parks. The MITRE Corporation. $10,000.
- Workshop on terrestrial research needs. Brookhaven National Laboratory. $12,000.

Expected Output:

Final reports published in the EPA Ecological Series and scientific journals on topics listed above.

Milestones/Delivery Dates:

All reports submitted and/or published during winter/spring 1980.

Project Title:
Effects of Acid Precipitation on Crops and Forests

Code:
EE 3

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
270K	290.2K

EPA Project Officer and Principal Investigator:
Jeffrey J. Lee
Environmental Research Laboratory
200 S.W. 35th Street
Corvallis, OR 97330
(503) 757-4671

Research Objectives and Project Description:

Objectives:
1) Determine effects of sulfuric nitric acid rain on foliage and yield of important farm crops. 2) Estimate effects of

sulfuric acid rain on forest productivity and nutrient cycling.

Description:

Survey of Sensitivity of Crops to Acid Rain: The field exposure chambers at the Schmidt Farm (under contract from Oregon State University) will be used to extend the FY 79 crop survey to a study of the sensitivity of crops to simulated sulfuric/nitric acid rain. One experiment will utilize two sulfuric:one nitric acid rain (the average proportion found in acid precipitation in the northeastern United States), at various pH levels. A second experiment will utilize rains containing various other proportions. A third experiment will evaluate the effect of soil sulfate status (i.e., sulfur deficient vs. nondeficient soils) on crop sensitivity to sulfuric acid-only rain. Most crops used in these three experiments will be selected from among those studied in FY 79. They will be chosen to achieve (1) adequate representation of foliar, seed, and root crops, and (2) a complete range of sensitivity. As far as possible, crops will be grown under the same conditions as in the FY 79 study.

Nutrient Cycling in Model Forest Ecosystems: Compared to agricultural systems, forests are relatively unmanaged. These ecosystems depend largely on natural nutrient cycling processes to make available adequate levels of essential nutrients to forest trees. They are thus vulnerable to perturbations in these cycles potentially caused by chronic exposure to acid precipitation. In June 1976, we initiated a multi-year experiment to estimate the effects of simulated sulfuric acid rain on forest productivity and nutrient cycling. Each of 16 model forest ecosystems receives simulated sulfuric acid rain of one of four pH values. Rainwater is sampled above and below the forest canopy, below the litter, within the root zone, and below the root zone. Biological processes being monitored include tree growth, leaf production, nutrient uptake, and litter decomposition. This experiment will terminate in FY 80, at which time the system will be intensively sampled. A major effort will then go into synthesizing the large amount of data into nutrient budgets, and constructing a simulation and statistical model. This concluding 3-year study will contribute significantly to terrestrial system studies being carried out under the EPA-Interagency Cooperative Agreement program, particularly with respect to modeling acidic precipitation effects on forest productivity.

Expected Output:

Reports as indicated below.

Milestones/Delivery Dates:

Publication of results of crop survey and forest ecosystem studies used in SO_x-Particulate criteria document, December 1979.

Report on throughfall and litter leachate studies (forest ecosystems). Submit for journal publication, February 1980.

Finished report on 1979 crop survey. Submit for journal publication, April 1980.

Initiate sulfuric-nitric acid rain crop survey, April 1980. (Will be completed in November).

Report on soil chemistry (forest ecosystems study). Submit for journal publication, June 1980.

Report on litter decomposition (forest ecosystems study). Submit for journal publication, September 1980.

Report on nutrient budgets (forest ecosystems study). Submit for journal publication, January 1981.

Final report for Forest Ecosystem Study, June 1981.

Project Title:

Greenhouse Microcosm Studies on Effects of Sulfuric and Nitric Acid Rain on Selected Agricultural Crops

Code:

EE 4

Funding Program:

Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
-0-	87.3K

EPA Project Officers and Principal Investigators:

Jeffrey J. Lee
Charles F. Powers
Environmental Research Laboratory
200 S.W. 35th St.
Corvallis, OR 973.0
(503) 757-4671

Research Objectives and Project Description:

Objectives:

To complement and supplement the Schmidt Farm crop survey in answering questions regarding effects of duration and frequency of acid rain on crops, developmental stages in plant life cycle when most sensitive, and the influence of other environmental factors on acid rain effects.

Description:

These studies will be conducted in the CERL greenhouse

complex and will complement those conducted concurrently at the Schmidt Farm. The greenhouse exposure system will be used to compare the individual contributions made by the sulfuric and nitric acid components of simulated acid rain. Short-term experiments will also be utilized to answer questions regarding the duration and frequency of acid rain and their effects on crop yield, the developmental stage in the plant's life cycle at which it is most sensitive to damage, and the influence of various environmental factors, such as light. Experiments are planned as follows:

- Exposure of bush beans to dilute simulated acid rains —sulfuric, nitric, 66% sulfuric:34% nitric, 66% nitric: 34% sulfuric (completed in October 1979).
- Effects of the sulfuric and nitric components of acid rain on the growth and yield of radish (a sensitive and rapidly maturing plant well suited to greenhouse experimentation):
  - — Growth and yield response to 66%:34% sulfuric and 66% sulfuric:34% nitric rain at pH 4.0, 3.5, 3.0, and control pH 6.0 will be obtained in the greenhouse microcosms. Parameters measured will be estimation of photosynthetic rate; biomass of leaves, edible portion and roots; macronutrient content; total protein; and nonstructural carbohydrate.
  - — Comparison of relative effects of sulfuric and nitric acids as constituents of acid rain. Concurrent exposure will be made in the microcosms to sulfuric, nitric, and the two sulfuric-nitric combinations at pH values determined from experiment (a).
  - — Effects of acid rain exposure under light and dark conditions. The effect of light on the impact of acid rain on the experimental plants will be studied in the microcosms. The type of acid rain and the pH levels to be employed will be determined from earlier greenhouse and Schmidt Farm experiments.

Expected Output:

Reports as indicated below

Milestones/Delivery Dates:

Report on bush bean studies. Final Report, September 1980.

Report on growth and yield response of radish. Final Report, September 1980.

Report on concurrent exposure studies. Final Report, September 1980.

Report on light and dark effects. Final Report, September 1980.

Project Title:

Effects of Acid Precipitation on Soil Biological Processes

Code:

EE 5

Funding Program:

Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
-0-	70.5K

EPA Project Officer and Principal Investigator:

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Research Objectives and Project Description:

Objective:

Determine effects of acid rain, metals, and both, on soil decomposer respiratory metabolism.

Description:

Effects of acid precipitation upon nonagricultural soils and litters may influence the productivity of both terrestrial and aquatic systems. Soil-litter microbiological organisms are responsible for the breakdown of organic matter, necessary for the release and recycling of nutrients. Acid deposition received at the soil surface, frequently augmented by heavy metals contained in the precipitation or mobilized from the soil, could adversely affect the microbial populations and thus disrupt the availability of nutrients to forests or adjacent water areas. Using laboratory microcosms, the effects of acid, metals, and combinations of both will be tested for qualitative and quantitative effects on soil decomposer respiratory metabolism in naturally acidic soils and litters. Some experiments will also incorporate addition of toxic organics, as a part of the toxics program. The experiments will be designed to elucidate the following questions with respect to effects of acid precipitation:

- What are the respiratory effects of acidification and heavy metal application to soils and litter, singly and in combination, on soil decomposition?
- Are there critical concentrations of acidification and

heavy metal application that synergistically affect soil or litter respiration?
- Do already acidic soils and litters show an increased sensitivity to further acidification and heavy metal application than less acidified soils and litters?
- What are the effects on leachate quality of soils or litters treated to acidification and heavy metal amendment?

Two acid litters and one soil (from the vicinity of Wheeling, West Virginia; the Adirondack Mountains in New York; and a west coast Douglas fir forest) will be treated with various mixtures and pH levels of sulfuric "acid rain" and heavy metals. Periodic measurements of total CO_2 respired (a measure of organic decomposition) will be observed in the gas phase of the microcosms, while pH, applied heavy metal, and aluminum will be observed in the "acid rain" leachate. (Aluminum in toxic quantities is often released from acidified soils.) Data will be treated to a 3-way analysis of variance (i.e., acid pH by metal concentration by toxic substances for each soil and metal) and results discussed in terms of the significance of treatment on decomposer respiration and leachate quality.

Expected Output:

Reports as indicated below.

Milestones/Delivery Dates:

Report on metals effects. Submit for journal publication, January 1981.

Report on acid effects. Submit for journal publication, January 1981.

Report on combined metals and acid effects. Submit for journal publication, January 1982.

Project Title:

Effects of Acid Rain on Mycorrhizal Fungi and Growth of Mycorrhizal vs. Nonmycorrhizal Conifers

Code:

EE 6

Funding Program:

Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
-0-	10K

EPA Project Officer:

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Principal Investigator:

James M. Trappe
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Research Objectives and Project Description:

Objectives:

Quantify effects of different mycorrhizal fungi in enhancing tolerance of conifers to acid rain; identify specific fungi that enhance tolerance most effectively.

Description:

Mycorrhizae are fungi that function as highly efficient extensions of the host tree's root system in obtaining nutrients from the soil. They are, therefore, of major importance in forest productivity. Acid rain can affect mycorrhizae directly through effects on photosynthesis of host trees and on the soil. At the same time, many mycorrhizae are tolerant to acidity, and can function to minimize adverse responses of trees to acid rain.

Studies will be made to evaluate and select fungi that best tolerate acid rain, inoculate them on hosts for comparing host x fungus interactions to a range to soil acidities under carefully controlled conditions, and finally test the best combinations under experimental acid rain.

Studies will be carried out in the laboratories and

greenhouse facilities of the Forestry Sciences Laboratory. The EPA Schmidt Farm will be used for acid rain experiments.

Expected Output:

Reports as indicated below.

Milestones/Delivery Dates:

Report on pH tolerance of mycorrhizal fungi, November 1980.

Report on effects of mycorrhizae on response of various tree species to acid rain, December 1980.

Report on effect of substrate acidity on mycorrhizae formation of Douglas fir in pure culture synthesis with fungi of different acid tolerances, September 1981.

Report on interactions of acid rain and mycorrhizal fungi on growth and morphology of Douglas fir seedlings, March 1982.

Project Title:

Assessment of the Sensitivity (Susceptibility) Index Concept for Evaluating Resources at Risk from Atmospheric Pollutant Deposition

Code:

EE 7

Funding Program:

Interagency Energy Environmental Program-OEPER-Energy Effects Division

Period of Performance/Funding:

FY 79	FY 80
-0-	50K

EPA Project Officer:

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Principal Investigator:

Orie Loucks
The Institute of Ecology
Butler University
Indianapolis, IN 46208

Research Objectives and Project Description:

Objectives:

1) To review existing literature on use of indices for quantifying resource status, predicting long-term trends in resource response to acid deposition, and assessing overall risks from acid atmospheric deposition in relation to air emission management; 2) to consider several options as to the form of a "susceptibility or sensitivity index" for use in determining resources at risk from energy development, and outline how such a measure would function in regional inventory of risk or in assessment of benefit from the acid precursor control; 3) to identify validation steps needed, data required (existing data or new measurements), and the steps required to complete testing and begin application of the sensitivity index in regional and national energy development decisions.

Description:

The existing evaluative indices as related to resources and a composite watershed sensitivity index will be evaluated and summarized. Included will be 1) lake chemistry indices (Kramer index, 1976; Henriksen's acidification model, 1979); 2) aquatic biological response measures (palynological indices, R. Davis, 1979; diversity indices, Loucks, 1970; and community response measures, Magnuson and Kitchell, 1979); 3) response in cationic exchange capacity and percent base saturation of soil CEC (McFee, 1979; Loucks, 1979); 4) assessment of vegetation response measures (forest site index and forest herb disturbance index, Wynn and Loucks, 1975); 5) hydrologically mediated nutrient and element flux relationships expressed as indices (Watson and Loucks, 1979); 6) measures for considered whole systems in terms of "ecosystem health" (Rapport and Friend, 1979); 7) and others as determined by literature and workshop searches.

Comparative, analytic assessment of concepts, considering each approach from the point of view of its strengths and limitations will be used in selecting two or more options for developing an integrated "sensitivity index" for effects of atmospheric pollutant deposition. These options or models will be designed to undergo intensive field evaluation as to operational feasibility during the course of subsequent validation studies. Detailed validation studies

will be planned or suggested to fully evaluate each index. Some of these may be field measurements or detailed analyses of existing large data bases from impacted regions such as the capacity of the index to predict the observed changes in soil, water, and biological systems from moderate to relatively heavy acid deposition.

Expected Output:

Publication in EPA Ecological Research Series and in scientific journals; validation plans for sensitivity (susceptibility) indices.

Milestones/Delivery Dates:

Draft indices assessment, September 1980.
Final report, December 1980.

Project Title:
Characterization and Quantification of the Transfer, Fate and Effects of SO_x, NO_x and Acid Precipitation on Forest Ecosystems Representative of the Tennessee Valley Region

Code:
EE 8

Funding Program:
Interagency Environmental Energy Program-OEPER-Energy Effects Division

Period of Performance/Funding:

FY 79	FY 80
250K	225K

EPA Project Officer:
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Principal Investigators:
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Research Objectives and Project Description:

Objectives:
Compare, characterize and quantify the transfer, fate and effects of sulfur and nitrogen compounds entering two forest watersheds on the Cumberland Plateau.

Description:
Two similar forested watersheds typical of those found on the Cumberland Plateau are being used as study sites. The soil and vegetation complex on the plateau is ideally suited to this type of study in that, when compared with other possible sites within the valley, any positive or negative impact should be easier to detect due to the thin, relatively infertile and unbuffered nature of the soil. The two sites chosen are located approximately 12 and 60 miles from the Widows Creek Steam Plant. The 12-mile site has been subjected to approximately 30 years of elevated sulfur and nitrogen input, while the 60-mile site located in a relatively remote area away from the influence of any major anthropogenic sulfur or nitrogen source is being used to represent background conditions on the plateau. Research conducted as part of this program will provide information on such key parameters as 1) the elemental composition of wet and dry atmospheric deposition; 2) the ability of forest canopies to scavenge airborne pollutants and the fate of these pollutants once scavenged; 3) the influence of air pollutants on the general fertility level of the soil and the ability of the soil to act as a long-term sink for air pollutants; and 4) the determination of allowable changes in system processes and transfers as a function of atmospheric inputs.

The first three years of the study were devoted to site selection, development, and characterization. A report (EPA-600/7-79-053) describing the objectives, facilities, and ecological characteristics of the study sites has been completed. Quantification of nutrient input/output relationships have been underway for approximately two years and will continue through FY 81. Research emphasis is currently shifting from baseline quantification to deposition modeling and comparative mass balance development.

Substudies dealing with specific processes or transfers are also being initiated as areas of need are identified.

The project is part of a $325K effort within the Interagency Program pertaining to the impacts of air pollution on soils and crop yields.

Expected Output:

The results from this effort are intended for use by investigators responsible for developing environmental criteria and standards and long-term environmental impact analysis. With the above information, more realistic input to the legislative process could be provided. In addition, enhanced understanding of system characteristics, processes, and transfers will be valuable in assessing the impact of new environmental perturbations associated with developing technologies.

Milestones/Delivery Dates:

Progress report on status of investigations, November 1980.

Progress report and report on decomposition mineralization response to SO_x and NO_x, December 1981.

Report on soil sorption - desorption processes, December 1982.

Model of SO_x and NO_x deposition to forest canopy, December 1982.

Model of ecosystem level responses to changing atmospheric inputs, December 1984.

Project Title:
Effects of Acid Precipitation on Terrestrial Ecosystems

Code:
EE 9

Funding Program:
Interagency Environmental Energy Program-OEPER-Energy Effects Division

Period of Performance/Funding:

FY 79	FY 80
258K	258K

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objectives:
(1) Determine effects of acid precipitation and acid aerosols on (a) forest and crop plants of northeastern United States; (b) microbial decomposition processes; (c) nitrogen cycle; (d) rhizobium-legume symbiosis; and (2) analyze effects using computer simulation models.

Description:
The approach is experimental, exposing plants and soils to artificial acid precipitation and acid aerosols in laboratory

range of tolerance of selected fish species. This information will be useful for developing responsive management programs and will provide input to the decisions related to air quality standards and the definition of "air quality related values." The $128K effort is part of a larger interagency program, involving pass-through funds for FY 80 of $550K to determine the impacts of air pollutants on fish, wildlife, and their habitats.

Expected Output:

Outputs will be in the form of technical reports and provide information for the larger project involving assessment, mitigation and PSD review relevant to the impacts of air pollution on fish, wildlife, and their habitats.

Milestones/Delivery Dates:

Annual progress reports, September 1980.

Annual progress reports, September 1981.

Final report and integration into air pollution impact models, September 1982.

Project Title:
Acid Precipitation Effects on Crops

Code:
EE 10

Funding Program:
Interagency Environmental Energy Program-OEPER-Energy Effects Division

Period of Performance/Funding:

FY 79	FY 80
10K	20K

EPA Project Officer:
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Principal Investigators:
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Argonne National Laboratory
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Research Objectives and Project Description:

Objectives:
To study the delay in plant senescence and increase in seed size observed in acid precipitation simulant. Research will attempt to separate the possible favorable effects of the nutrients from the potential adverse effects of reduced pH.

Description:
Simulated rain treatments encompassing a range of pH values but having similar concentrations of the major nutrients (N and S, in particular) will be applied to soybeans throughout their life cycle. Effects on plant development, physiology, growth and yield will be evaluated. Other variables to be incorporated into these greenhouse and controlled environment experiments based on the initial findings will include (1) soil versus foliar application, (2) soil fertility, (3) plant age during treatment, (4) rate of acid simulant application, (5) growth conditions, and (6) other crop species. These studies will be supported in FY 80 as a part of a continuing $232K EPA/OEPER-funded program involving the effects of gaseous pollutants on midwestern crops.

Expected Output:

Results of this research are regularly summarized in Argonne National Laboratory Research Reports and are periodically presented at technical meetings and published in appropriate scientific journals. This research effort will contribute to the development of air quality criteria and the establishment of cause and effect relationships involving precipitation acidity and ions associated with the acidic events.

Milestone/Delivery Dates:

Report on progress and initial findings, November 1980.

Project Title:
Effects of Acidified Precipitation on Fish Resources

Code:
EE 11

Funding Program:
Interagency Environmental Energy Program-OEPER-Energy Effects Division

Period of Performance/Funding:

FY 79	FY 8034
-0-	128K

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objective:
Determine the impact of acid precipitation on the reproduction of fish species of economic and recreational importance.

Description:
The success of current programs for restocking northeastern water systems with salmonids and other species requires information on the short-term and long-term consequences of acid precipitation on these species. This field and laboratory research effort will investigate the effects of low pH and exposure time on reproductive response and chambers and in the field, to determine threshold limits for injury or biological change. Models of forest growth, the forest floor, and plant growth are used to analyze both extent of injury and relationships of observable injury to growth.

Expected Output:

Basic knowledge of acid precipitation and acid aerosol effects. Integrated models of (1) forest nutrient cycling and growth, and (2) materials routing during plant growth. Analysis of plant and forest growth senstivity to types of acid rain/acid aerosol injury. Final output is publication in refereed journals. Publications of prior research are available via the principal investigator.

Milestone/Delivery Dates:

Multi-year research plan for FY 81 and beyond, January 1980.

Report on field test involving acid rain effects on soybeans, June 1980.

Progress report on FY 80 activities, November 1980.

Project Title:
Ecological Effects of Coal Combustion: Interactive Effects on Vegetation of SO_2, Ozone, and Acid Precipitation

Code:
EE 12

Funding Program:
Interagency Environmental Energy Program - OEPER -Energy Effects Division

Period of Performance/Funding:

FY 79	FY 80
131K	131K

EPA Project Officer:
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Principal Investigators:
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Research Objectives and Project Description:

Objectives:
Evaluate the effects on terrestrial vegetation of individual and combined doses of energy-related atmospheric pollutants occurring over large regions of the eastern United States. Assess the degree to which present secondary ambient air quality standards adequately protect vegetation from measurable damage.

Description:
The experimental approach utilizes a combination of laboratory, greenhouse, and field studies designed to (1) establish thresholds for physiological damage from single and combined doses of SO_2, O_3, NO_2, and acid rain; and (2) evaluate relationships between the level and duration of ambient exposure episodes, short-term physiological response, and yield of selected forest and agricultural species. The project will involve a series of controlled fumigation studies in the laboratory using controlled environment exposure chambers. This work will be closely coupled with greenhouse experiments involving exposure of plants to simulated acid rainfall designed to quantify effects on the plant-soil system. The project will also involve the use of charcoal-filtered field chambers to quantify impacts of ambient air quality regimes on native vegetation and relate these impacts to relevant quantitative indices of the exposure history.

Expected Output:

Results of this research will be disseminated through open literature publications and the development of more realistic vegetation response models (accomplished with colleagues in related projects). The research will provide information for evaluating yield losses, weighing alternative energy sources, and designing relevant experiments.

Milestones/Delivery Dates:

Publications and progress reports on dose/response impacts of gaseous pollutants and acid rain, November 1980.

Project Title:
The Mobilization and Transportation of Soil and Sediment Components into Pollutants by "Acid Precipitation" and Related Factors

Code:
EE 13

Funding Programs:
Anticipatory Research Program
Water Quality - Freshwater Ecological Effects

Period of Performance/Funding:

FY 79	FY 80
93K	182K*

EPA Project Officer and Principal Investigator:
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Research Objectives and Project Description:

Objectives:
The objectives of this study are to identify and determine which chemical species are released into freshwater from soil and sediments and become pollutants as a direct result of components in rain and snow that originated from the combustion of fossil fuels and to determine the resultant impacts on sensitive lakes.

Description:
The definition of reactive components in precipitation will be done using combinations of collection, separation, and concentration techniques and laser raman spectroscopy, ion chromatography, atomic absorption and emission spectrometry, anodic stripping volametry and titrametric techniques on carefully selected field and laboratory systems. Potentially sensitive lakes in northern Minnesota and Wisconsin will be studied during the most important time period for adverse acid precipitation effects to occur. Distributions of chemical species and chemical forms in both solid and liquid phases will be verified using chemical models and laser raman techniques. Chemical residue measurements and population estimates of aquatic organisms will be made to determine relative and absolute availability and form of the pollutant(s). Dose response relationships will be measured for watersheds during snow accumulation-melt periods.

Expected Output:

Publication of results in scientific journals and the EPA Ecological Research Series. Presentation of results at conferences and international meetings.

Milestones/Delivery Dates:

Determine acid reactive chemical forms present in precipitation, December 1980.

Determine winter loadings and effects on some sensitive lakes in northeastern Minnesota and Wisconsin, June 1980.

Determine pathways for contaminant transformation and mobilization due to "acid" precipitation, December 1981.

Final project report and publication, December 1981.

*Money considered as acid rain research.

Project Title:
Impacts of Airborne Pollutants on Wilderness and Park Areas of Northern Minnesota, Wisconsin, and Michigan

Code:
EE 14

Funding Program:
Interagency Energy Environmental Program-OEPER-Energy Effects Division

Period of Funding:

FY 79	FY 80
150K	120K

EPA Project Officer and Principal Investigator:
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Research Objectives and Project Description:

Objectives:
The goal of this study is to examine previously unanswered questions concerning potential effects of the proposed Atikokan, Ontario, power plant on ecosystems in the Boundary Waters Canoe Area (BWCA) and Voyageurs National Park (VNP) of Minnesota by using the most relevant data and analytical methods. The principal steps are to focus on (1) the ultimate deposition of emissions from the plant (rather than only on pollutant concentrations); (2) the use of a time varying grid model with provision for atmospheric transformations; and (3) a detailed review of all available data from the region on atmospheric deposition of pollutants, water quality, and effects. The results will be considered in relation to a review of responses by terrestrial and aquatic organisms to changes in the chemistry of this environment.

Description:
The sensitive aquatic and terrestrial receptors in the BWCA-VNP region will be described quantitatively, and this information assessed in terms of what is currently known about the impacts of atmospheric pollutants. Specific conclusions based on factual information, probable consequences, and possible impacts of the proposed coal-fired power generating station at Atikokan, other regional sources, and long-distance sources are planned.

The study to date supports, in part, the conclusions reached previously concerning the predicted air concentrations of sulfur dioxide, but differs significantly with the conclusions concerning the significance of future impacts. When the total emissions from the proposed power plant are considered, the increased loadings of sulfuric and nitric acids, fly ash, and mercury as an addition over and above other regional sources will, with high probability, have significant consequences for the sensitive receptors in the BWCA-VNP region, especially for the future of sport fisheries and other aquatic resources.

Expected Output:

Publication in EPA Ecological Research Series.

Milestones/Delivery Dates:

Publication date: Volume I, March 1980.
Publication date: Volume II, March 1981.

Project Title:
Generalization of Water Quality Criteria Using Chemical Models

Code:
EE 15

Funding Programs:
Anticipatory Research Program
Water Quality - Freshwater Ecological Effects

Period of Performance/Funding:
October 30, 1976 - October 29, 1979

FY 79	FY 80
100K	11.1
(10K)*	

EPA Project Officer:
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Principal Investigators:
Donald K. Harris
Vincent R. Magnuson
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Duluth, MN 55812

Research Objectives and Project Description:

Objectives:
The final goal is the correlation of toxicity in a particular ecosystem with chemical speciation and use of these correlations to determine realistic water standards. Biological activity most commonly correlates best with specific forms or species of contaminants, and water quality standards would be more soundly structured on the probability of an offending species being present or available.

Description:
Three areas of activity are involved in meeting project goals: a) predictive computer modeling utilizing speciation and toxicity data, b) assembling a data base on speciation from literature, experimentation, and estimation, and c) collection and interpretation of toxicity data from literature and experiments. These models are an essential part of the Innovative Research Project, "Mobilization and Transportation of Soil and Sediment Components into Pollutants by 'Acid Precipitation' and Related Factors."

Expected Output:

EPA Ecological Research Series - final report, scientific journal publications.

Milestones/Delivery Dates:

Complete draft of revised chemical speciation model, October 1978.

Complete final revised chemical speciation model, October 1979.

Apply model to representative water quality criteria, October 1979.

Project completion - expected final output, September 1980.

*Money considered as acid rain research.

Project Title:
Experimental Field Studies
to Evaluate the Effects of Acidification
on a Stream Ecosystem

Code:
EE 16

Funding Program:
Interagency Energy Environmental
Program-OEPER-Energy Effects Division

Period of Performance/Funding:

FY 79	FY 80
-0-	59K

EPA Project Officers:
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Principal Investigator:
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Research Objectives and Project Description:

Objectives:
The objectives of the proposed studies are to evaluate more fully the impact of low pH stress on a low alkalinity stream ecosystem (Hubbard Brook, NH). The experiments are designed to determine the effect of pH on nutrient cycling and energy flow in an area subjected to sulfuric and nitric acids from precipitation. The following determination proposed (1) comprehensive chemical measurements of stream water; (2) drift densities of the fauna; (3) transport of particulate organic matter; (4) biomass change at different pH levels; and (5) changes in buffering capacity of stream sediments in relation to water chemistry.

Description:
The proposed work is to conduct experimental field studies on the impact of low pH stress on a mountain stream ecosystem. The experiments are designed to determine how and to what extent low pH levels effect nutrient cycling and energy flow of a natural stream (Hubbard Brook, NH) subjected to input of stream acid (H_2SO_4 and HNO_3) from incident precipitation. The metal data collected in water, sediment, plant, and fish tissue in acidified channels of the Monticello Ecological Research Station will be evaluated, considered in their experimental design and discussed in their subsequent reports.

Expected Output:

Final report for EPA Ecological Research Series.

Milestones/Delivery Dates:

Draft final report, September 1981.
Start cooperative agreement, January 1980.

Project Title:
Coal Fired Steam Plants:
Human and Environmental Exposure
to Air and Water Pollutants

Code:
EE 17

Funding Program:
Interagency Energy Environmental
Program-OEPER-Energy Effects Division

Period of Performance/Funding:

FY 79	FY 80
576K (57.6K)*	162.4K

EPA Project Officer:
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Principal Investigators:
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Research Objectives and Project Description:

Objectives:
The objectives are to document the overall environmental impact of construction and operation of a coal-fired power plant and generalize the findings to all coal-fired power plants.

Description:
This research would extend work carried out over the past several years at the Columbia power plant site. While previous work under Grant No. R803971 was mainly directed towards documenting environmental changes. this work focuses on human and environmental exposures to air and water pollutants resulting from coal combustion. Specific sections of this project address 1) air quality, 2) water quality, 3) wetland and aquatic ecology, and 4) data integration, assessment, and transferability.

Expected Output:

Final reports published in the EPA Ecological Research Series and scientific journals on topics listed below.

Milestones/Delivery Dates:

Detailed identification and quantification of stack emissions, June 1981.

Transport and transportation of stack emissions, June 1981.

Deposition dynamics of plumes from stack emissions, June 1981.

Effects and alternative methods of fly ash disposal, June 1981.

Exposure of generating station emissions to local residents, June 1981.

Health assessment of aquatic and terrestrial receptors, June 1981.

Accumulation and transformation of chemicals in fish, June 1981.

Wetlands and aquatic ecology impacts from generating stations, June 1981.

Model assessment, integration and data interpretation from above, June 1981.

*Money considered as acid rain research.

Project Title:
Effects of Precipitation and Solutes on the Surface and Groundwater Quality in the Filson Creek Watershed Area

Code:
EE 18

Funding Program:
Interagency Energy Environmental Program-OEPER-Energy Effects Division

Period of Performance/Funding:

FY 79	FY 80
7K	5K

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objectives:
The purpose of this agreement is to analyze and interpret data (1976-1979) for the Filson Creek watershed area concerning the effects of precipitation and solutes on surface and groundwater quality. The relevant data concerning the effects of water will be gathered, quality assured, interpreted, and reported for publication in the EPA Ecological Research Series.

Description:
Sets will include, but are not limited to, USGS data 1976-1979, USFS 1976-1979, EPA 1978-1979, and data collected for the dissertation of D.I. Siegel, University of Minnesota, and Minnesota Copper/Nickel Project data. The informational categories will include methodology (field, lab, quality assurance), hydrology (stream flow, and groundwater hydrographs, monthly hydrology budgets), geology, soils, vegetation, water quality (precipitation, surface and groundwater), statistical (treatment and analyses) and mass flow and balance computations of solutes.

Expected Output:
EPA Ecological Research Series report.

Milestones/Delivery Dates:
EPA Ecological Research Series report, November 1980.

Project Title:
Acid Effects on Fathead Minnows and Macroinvertebrates in Outdoor Experimental Channels

Code:
EE 19

Funding Program:
Water Quality - Freshwater Ecological Effects

Period of Performance/Funding:

FY 79	FY 80
365K (36.5K)	-0-

EPA Project Officer and Principal Investigator:
John W. Arthur
Monticello Ecological Research Station
P.O. Box 500
Monticello, MN 55362
(612) 295-5145

Research Objectives and Project Description:

Objectives:
1) Determine survival, growth and reproductive effects to fathead minnows; 2) determine effects on life history and community structure of macroinvertebrates; and 3) determine changes in emergence of aquatic insects.

Description:
The objective is to determine impact of acidifying river water to aquatic life in outdoor experimental channels. Three channels were used—one at ambient pH, a second dosed with sulfuric acid to a pH of 6.0-6.2, and a third channel dosed to a pH of 4.9-5.0. Study was conducted for 18 weeks from May through September 1979. Results will be compared with pH criteria recommended by EPA to protect aquatic life.

Expected Output:

Final report to be published in EPA Ecological Research Series and scientific essence in journals.

Milestones/Delivery Dates:

Start study, May 1979.
End Study, September 1979.
Final report due, October 1980.

Project Title:

Effect of Acid on Zooplankton Community Structure and Functional Response in an Experimental Mesocosm and Northern Minnesota and Wisconsin Lakes

Code:

EE 20

Funding Programs:

Water Quality - Freshwater Ecological Effects
Interagency Energy Environmental Program-OEPER-Energy Effects Division

Period of Performance/Funding:

FY 79	FY 80
5K	10K

EPA Project Officers:

Kenneth E. F. Hokanson
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Gary E. Glass
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Duluth, MN 55804
(218) 727-6692

Principal Investigator:

Jack R. Hargis
University of Minnesota-Duluth
Department of Biology
221 Life Science Bldg.
Duluth, MN 55812
(218) 726-7276

Research Objectives and Project Description:

Objectives:

Describe the zooplankton community structure (species components, diversity, biomass) and functional response (reproductive and feeding rates) in three outdoor experimental mesocosms as a function of nominal pH treatments of 5.0, 6.0, and control (7.5-8.5), and in lakes in northern Minnesota and Wisconsin.

Description:

The effects of sulfuric acid treatment on the zooplankton community will be described as one separate ecosystem-level component to define the sensitive ecosystem-level parameter to acid stress. This parameter will be a useful ecological monitoring tool for sensitive ecosystems (macrocosms).

Expected Output:

M.S. Thesis, University of Minnesota-Duluth.

Milestones/Delivery Date:

June 1980

Project Title:
Explorations into the Effects of Acid Conditions on Aquatic Invertebrates

Code:
EE 21

Funding Program:
Water Quality - Freshwater Ecological Effects

Period of Performance/Funding:

FY 79	FY 80
5.5K	-0-

EPA Project Officer:
Richard L. Anderson
Environmental Research Laboratory
6201 Congdon Blvd.
Duluth, MN 55804
(218) 727-6692

Principal Investigator:
John Gavre
University of Minnesota-Duluth
Duluth, MN 55812

Research Objectives and Project Description:

Objective:
1) Determine acute toxicity of low pH on snail (*Helisoma sp.*). 2) Determine effect of six-week exposure on growth and reproduction of the same species. 3) Determine susceptibility of snail eggs to low pH.

Description:
Snails were collected and exposed in the laboratory to the condition described in the objectives. The lowered pH was produced with H_2SO_4.

Expected Output:

In-house final report.
Master of Science thesis for Mr. Gavre.

Milestones/Delivery Date:

In-house final report, September 1980.

Project Title:
The Environmental Impact of Energy-Related Organic Compounds on Aquatic Life

Code:
EE 22

Funding Program:
Interagency Energy Environmental Program-OEPER-Energy Effects Division

Period of Performance/Funding

FY 79	FY 80
217K (21.7K)*	60K

EPA Project Officer:
John I. Teasley
Environmental Research Laboratory
6201 Congdon Blvd.
Duluth, MN 55804
(218) 727-6692

Principal Investigator:
Robert Carlson
University of Minnesota-Duluth
Duluth, MN 55812
(218) 726-7231

Research Objectives and Project Description:

Objectives:
The objectives are to evaluate the effect of various types of particulate matter upon the biological and chemical interactions of selected, energy-related chemicals, including polynuclear aromatic hydrocarbons, and to determine the components in atmospheric precipitation.

Description:
The potential hazard to aquatic organisms of exposure to sediment, suspended microparticulates, and water known to contain energy-related organic compounds will be assessed. The program is being approached in the following ways: 1) The organic content of extracts of tissue, microparticulates (e.g., fly ash, sediment, etc.) and water from areas impacted by energy production facilities that use coal as their fuel source are being compared with similar extracts from areas not subject to such stress. 2) Biological systems (i.e., fish, invertebrates, bacteria) are being evaluated to determine if there are adverse effects such as toxicity, bioaccumulation, or mutation upon exposure to PAHs, polycyclic aromatic phenols, and azarenes. 3) The chemical and biological properties of

photo-oxidation and chlorination products of energy-related organic compounds are also being investigated. 4) The effect of adsorption or organic compounds on particulates in mediating biological response and chemical reactivity are also being studied.

Expected Output:

EPA Ecological Research Series report.

Milestones/Delivery Dates:

Final report, June 1979.

*Money considered as acid rain research.

Project Title:
Examination of Fish Recruitment in 130 Wisconsin Lakes (pH 4.5 - 7.5)

Code:
EE 23

Funding Programs:
Anticipatory Research Program
Water Quality - Freshwater Ecological Effects

Period of Performance/Funding:

FY 79	FY 80
-0-	35K

EPA Project Officer and Principal Investigator:
Tom Roush
Environmental Research Laboratory
6201 Congdon Blvd.
Duluth, MN 55804
(612) 727-6692

Research Objectives and Project Description:

Objectives:
To determine reproductive success of fishes in select Wisconsin lakes. These lakes represent the low end of the continuum of buffering capacities determined by prior water quality surveys. The snow-associated acid loading will be known for these watersheds and previous species complexes are known.

Description:
Shoreline seining and ichthyoplankton netting will be performed in the habitats where young-of-the-year fishes would be expected. Due to the various species spawning at different times in the spring, July and August are to be the sampling period. This will allow dispersion of the young fish so knowledge of lake specific spawning sites is not critical even though relatively fewer young will be in the lakes.

Expected Output:

Knowledge of what species of fish developed young-of-the-year for lakes with various water qualities (pH, alkalinity, etc.) and known atmospheric acid additions.

Milestone/Delivery Dates:

Report, October 1981.

Project Title:
Impact of Acid Rain on Drinking Water in New England and New York

Code:
EE 24

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
-0-	100K

EPA Project Officer:
Gary S. Logsdon
Straighten Municipal Environmental Research Laboratory
26 W. St. Clair St.
Cincinnati, OH 45268
(513) 684-7345

Principal Investigator:
To be selected

Research Objectives and Project Description:

Objectives:
Phase I: Review literature for water quality data.
Phase II: Survey water quality of water sources and tap waters of selected water utilities in New York and New England.

Description:

Description:
Over the two-year project period, an interdisciplinary working group will:

- Define the region of concentration (airshed).
- Estimate the man-made and natural sources of S, N, and

Phase I: The principal investigator will review and compile present and historical water quality data for parts of New York and New England that may be affected by acid precipitation. In the first phase, data will be obtained by reviewing literature and visiting offices of agencies that have water quality data in their files. State health departments, state geological survey agencies, and state water resource and natural resource agencies are considered good sources for the data being sought. The data collected in Phase I will be reviewed to learn if historical trends can be seen and to locate waters currently low in pH and alkalinity.

Phase II: Water utilities with sources having low pH and alkalinity will be visited in Phase II. Samples will be collected and analyzed for pH, alkalinity, metals, and other constituents of interest. Both source water and tap water samples will be tested. Source water data will show the quality of water sources for utilities and in some cases the quality of water being used by individual households. Tap water samples will show the effects of water treatment and distribution and should reveal the extent to which water quality is changing because of the dissolution of metals from distribution lines or plumbing.

In the latter part of Phase II, a limited amount of follow-up sampling will be done at water sources having the lowest values of alkalinity and pH. The follow-up sampling will be carried out just after important runoff events, such as a heavy rain that ends a dry period, or spring snowmelt. Follow-up sampling is intended to reveal extreme conditions related to specific events in the watershed.

Expected Output:

A report will be prepared.

Milestones/Delivery Dates:

Start, June 1980.
Complete August 1981.

Project Title:

Budget of Man-Made Sulfur, Nitrogen, and Hydrogen Ions Over the Eastern United States and Southeastern Canada Airshed

Code:

EE 25

Funding Program:

Integrated Assessment Program
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
100K (15K)*	105K (20K)*

EPA Project Officer:

Lowell Smith, Director
Program Integration and Policy Staff
RD-681
401 M Street, S.W.
Washington, D.C. 20460
(202) 426-9434

Principal Investigator:

Rudi B. Husar
Department of Mechanical Engineering
Washington University
St. Louis, MO 63130
(314) 889-6047

Research Objectives and Project Description:

Objectives:
The main objective is to summarize existing scientific knowledge and point out information gaps in the ability to determine a regional environmental budget of man-made sulfur, nitrogen, and hydrogen ions released or formed within the northeastern U.S. and adjacent vicinity of Canada. The regional budget is intended to establish the amount, chemical composition, and residence times of these substances in the atmosphere and in terrestrial and aquatic ecosystems. This information is required in order to estimate the overall potential for adverse impact due to the long-term accumulative effects of these substances.

H^+ over the eastern U.S. and southeast Canada in space and time.
- Estimate atmospheric concentration of these species in space and time.
- Estimate dry and wet deposition of S, N, and H^+ in space and time.
- Compare S, N, H^+ concentrations in terrestrial and aquatic systems to "unperturbed" values.
- Construct a regional budget for S, N, and H^+.
- State gaps of knowledge and recommend research areas.

Expected Output:

The major product will be a report containing the status of understanding of the S, N, and H^+ budget in air, land and water over the eastern U.S. and southeast Canada. Special emphasis will be placed on the chemical characterization (e.g., acidity) of these compounds. The report is to serve as background material for EPA and other environmental research and development administrators. Such a thorough, multidisciplinary examination should minimize future surprise effects by anticipating their occurrence.

Milestones/Delivery Dates:

Final Report, March 1981.

Project Title:
Design of Economic Methodology for Assessing the Benefits of Controlling Acid Precipitation

Code:
EC 1

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
52K*	52K*

EPA Project Officer:
Alan Carlin
Office of Research and Development
RD-676
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Washington, D.C. 20460
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Principal Investigator:
Thomas Crocker
Department of Economics
University of Wyoming
Laramie, WY 82071
(307) 766-6423

Research Objectives and Project Description:

Objectives:
Design economic methodologies for assessing the benefits of controlling acid precipitation and provide preliminary indications of the benefits of control as well as those economic sectors likely to gain most from control.

Description:
The project will identify the analytical properties and data requirements of alternative biological and physical science measurement techniques, develop a set of criteria for ordering the above in terms of their contributions to benefits assessment, summarize other benefits assessment efforts transferable to this problem, specify suspected ranges of biological and physical effects, and make preliminary approximations of the economic benefits.

Expected Output:

Interim report on preliminary approximations of the economic gains from controlling acid precipitation.

Milestones/Delivery Dates:

Interim Report, January 1980.
Final Report, August 1980.

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*Part of Larger Cooperative Agreement on "Methods Development for Assessing Air Pollution Control Benefits."

Project Title:
Monitoring System Support
to Acid Rain Program

Code:
MT 1

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
130K	235K

EPA Project Officer:
Franz Burmann
Environmental Monitoring Systems
Laboratory MD-75
Research Triangle Park, NC 27711
(919) 541-2106

Principal Investigators:
Gerald Akland - Task 1
Gardner Evans - Task 1
Environmental Monitoring Systems
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V. Ross Highsmith - Task 2
Environmental Monitoring Systems
Laboratory MD-75
Research Triangle Park, NC 27711
(919) 541-3082

Research Objectives and Project Description:

Objectives:

Task 1: Provide an integrated, centralized data bank for all monitoring projects designed to study acid rain deposition on the environment.

Task 2: Establish a core monitoring network for use in identification of major variables and development of a reliable acid rain monitoring system.

Description:

Task 1: In order to ensure the success of the long-term atmospheric chemistry monitoring program, EPA has established a data management system to coordinate the storage and retrieval of contributed data from the National Atmospheric Deposition Program, MAP3S, WMO, TVA, CANSAP, and EPRI. The data management system is being developed and operated by EMSL/RTP. It became operational in December 1979 and will be in a pilot phase through June 1980. During this period EPA will carefully monitor the data flow through the system and survey user requirements and problems.

The purpose of the archive is to preserve atmospheric deposition information collected across the U.S. and Canada to facilitate the access to the information for spatial and temporal retrievals and to permit intercomparisons among parameters. The system has easy access (direct dial-up) to the data base with summary retrievals in both digital and graphic form. It is hoped that through EPA's support, there will be a better understanding of the complex relationships between various forms of deposition and impact on the ecosystem.

Task 2: Aerochem samplers, pH meters, conductivity measuring devices and ancillary equipment will be purchased, checked out, and shipped to monitoring sites. The core network will be used to examine in detail the determination of pH and conductivity at the time of collection of the precipitation and the transportation of the sample to a laboratory, with subsequent redetermination of the field measured pH and conductivity values. Redetermination of field measurements is a good means to examine the integrity of the complete sampling and analysis system and thus will provide a measure of system validity.

Expected Output:

Data management support for routine and specialized research needs. A reliable acid rain monitoring system.

Milestones/Delivery Date:

Purchase, check out, and supply Aerochem samplers, pH meters, conductivity measuring devices, and ancillary equipment to up to 20 stations in support of the precipitation network, April 1980.

Update users guide, June 1980.

Expand capabilities for inclusion of solid deposition (report of progress), September 1980.

Incorporate QA measures (feasibility study), September 1980.

Project Title:
Quality Assurance Guidelines
and Reference Samples

Code:
MT 2

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
-0-	65K

EPA Project Officer:
M. Rodney Midgett
U.S. Environmental Protection Agency
Quality Assurance Division
MD-77
Environmental Monitoring Systems
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Research Triangle Park, NC 27711
(919) 541-2111

Principal Investigator:
(for milestone #2 only)
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Rockwell EMSC
2421 W. Hillcrest Dr.
Newbury Park, CA 91320
(805) 498-6771

Research Objectives and Project Description:

Objectives:
To develop a quality assurance program for acid precipitation monitoring.

Description:
Quality assurance guidance will be prepared for the development and operation of precipitation monitoring networks. Suitable quality control reference samples applicable to the analysis of components of precipitation will be developed.

Expected Output:

- Thoroughly validated quality assurance reference materials.
- Guidelines for proper quality assurance applicable to acid precipitation monitoring.

Milestones/Delivery Dates:

Develop acid precipitation reference materials for pH, conductivity, SO_4^{-2}, NO_3^-, PO_4^{-3}, Cl^-, NH_4^+, K^+, Na^+, Ca^{+2}, and Mg^{+2} and obtain confirmatory analysis, June 1980.

Develop manual for acid precipitation network covering siting, standard operation procedure, quality assurance, and handling, September 1980.

Project Title:
Monitoring System Support
to Acid Rain Program

Code:
MT 3

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
-0-	150K

EPA Project Officer:
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Principal Investigator:
Task 1 - V. Ross Highsmith
(919) 541-3082
Task 2 - Rodney Midgett
(919) 541-2196
Environmental Monitoring Systems
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MD-75
Research Triangle Park, NC 27711

Research Objectives and Project Description:

Objectives:
Task 1: Establish a core monitoring network for use in identifying major variables and developing a reliable acid rain monitoring system.

Task 2: Develop and implement a quality assurance program to ensure data quality.

Description:
Task 1: Develop cooperative agreement with Colorado State University for collection of samples and to arrange for the analyses of precipitation samples by Illinois State Water Laboratory and procure and field test prototype devices which may be available for on-site direct collection and analysis of precipitation for pH and conductivity.

Task 2: Develop and implement a quality assurance program for the Core Network and the central analytical laboratory. Conduct field audits and obtain split sample data. Arrange for the training of station operators.

Expected Output:

Establishment of an acid rain monitoring system including a quality assurance program. Data of known precision and accuracy.

Milestones/Delivery Dates:

Initiate cooperative agreement with Colorado State University for collection of samples (by Illinois State Water Laboratory), November 1979.

Provide training manuals and training to station operators, April 1980.

Obtain split sample data to be used in evaluation of quality assurance for pH and conductivity and issue report, May 1980.

Develop and implement a quality assurance program consisting of a limited system audit (approximately 2 sites) and periodic performance audits of the EPA CORE Network (approximately 15 sites) and Illinois State Water Laboratory, August 1980.

Procure and field test prototype device(s) which may be available for on-site direct collection and analysis of precipitation matter for pH and conductivity and issue report, September 1980.

Project Title:
Precipitation Chemistry Network

Code:
MT 4

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
160K	160K

EPA Project Officer:
Dan Golomb
Office of Environmental Processes
and Effects Research
RD-681
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Washington, DC 20460
(202) 426-0264

Principal Investigator:
M. Terry Dana
Battelle Pacific Northwest Laboratories
PO Box 999
Richland, WA 99352
(509) 942-2861

Research Objectives and Project Description:

Objectives:
Precipitation chemistry data, from samples collected on a precipitation event basis, are an important part of the data base used in fulfilling the overall objective of MAP3S, which is to provide models for prediction of the impact of fossil-fuel emissions on air and precipitation quality in the northeastern United States. Of key importance to the MAP3S effort are 1) maintenance of the network sampling operations at the eight-site network; 2) prompt chemical analysis of samples for all relevant species, including pH and sulfur and nitrogen oxides; and 3) rapid reporting to the MAP3S and outside communities of results.

Description:
An eight-site network has been established in the region from Illinois east and from Delaware north, where precipitation event samples are collected by automatic wet deposition-only samplers. (Through FY 1980, the sites are funded separately by DOE.) The samples are shipped to Battelle Pacific Northwest Laboratories, where chemical

analyses for the following species are conducted: pH, conductivity, SO_2, $SO_4^=$, NO_2^-, NO_3^-, Cl^-, PO_4^{3-}, NH_4^+, K^+, Ca^{++}, and Mg^{++}. The results are computer coded and provided to users in three ways: 1) by bimonthly paper and microfiche reports; 2) through annual summary PNL document reports, and 3) on magnetic tape in the MAP3S Data Bank. The network has been in operation since September 1976. Two annual summaries have been released and, through monthly and bimonthly (FY 1980) data reports, data are made available within two months of the samples' arrival at the laboratory.

Special studies run concurrently with routine event sampling and chemical analysis. During the first three years of operation, collector comparison studies of a special examination of the relationship between dissolved SO_2 and sulfate deposition were conducted.

Expected Output:

In addition to continuing to provide chemical analysis reports and maintenance of the network (which involves about 75 percent of the effort), analyses of precipitation chemistry data from the MAP3S region will examine seasonal and geographical variations and correspondence between the various sites' collections for selected large-scale storms. As the data bank grows, trend analyses will determine if there are any discernible changes in the precipitation quality in the region over periods of several years or more. During FY 1980, in a cooperative effort with Brookhaven National Laboratory (Gilbert S. Raynor), a project aimed at upgrading some of the sites to include air quality and mixing height measurements will begin. In addition, selected weather episodes (as coordinated by MAP3S modelers and field experiment planners) will be targeted for sequential (subevent) sampling at all sites.

Milestones/Delivery Dates:

Data Reports and MAP3S Data Bank Updates, bimonthly.

Third Periodic Summary Report, February 1, 1980.

Conversion of most site collector equipment to commercial models, July 1, 1980.

Fourth Periodic Summary Report, October 1, 1980.

Selection of sites for additional measurements, October 1, 1980.

Project Title:

Precipitation Chemistry in Western Oregon

Code:

MT 5

Funding Program:

Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
-0-	32.2K

EPA Project Officer and Principal Investigator:

Charles F. Powers
Environmental Research Laboratory
200 S.W. 35th Street
Corvallis, OR 97330
(503) 757-4671

Research Objectives and Project Description:

Objectives:

Obtain background data on the chemistry of essentially culturally unmodified precipitation, and determine how it is modified as it progresses inland.

Description:

Two "AEC type" precipitation/dry fallout collectors will be situated in the Coast Range and the Willamette Valley of western Oregon. The collection sites will become components of the National Atmospheric Deposition Program (NADP) network. The objectives are to obtain background information of the chemistry of essentially culturally unmodified precipitation as it enters the North American continent, and to determine how the chemistry is modified as preciptation regimes move across western Oregon. A third collection site, operated by Oregon State University in the Cascade foothills, will complete a "sea-to-the-mountains" transect. In addition, two experiments on the temporal and spatial variability of precipitation chemistry during discrete storm events are planned for the Corvallis area during the coming winter, and samples will be collected and analyzed ad hoc at the CERL laboratory site. Snow samples from selected locations in the Coast Range and Cascades will also be analyzed, to determine whether an accumulation of airborne materials (e.g., heavy metals, nutrients, acidity) occurs over the winter, as has been observed in the northeastern U.S. and in Scandinavia. The sudden release of acidity and aluminum during snow pack meltoff in the Adirondacks, for example, has resulted in catastrophic fish kills.

These investigations will significantly supplement and reinforce the present NADP network output, as well as current research by other investigators on precipitation chemistry and acidity in the Portland, Seattle, San F ancisco, and Los Angeles areas.

Expected Output:

Reports as indicated below.

Milestones/Delivery Dates:

Establish NADP stations, November 1979.

Input data to NADP weekly. Data for the entire network published regularly by NADP.

Report on 1979-80 season precipitation chemistry. Submit for publication August 1980.

Project Title:

Acid Rain: National and International Assessment of Potential Impacts

Code:

MT 6

Funding Program:

Interagency Energy Environmental Program-OEPER-Energy Effects Division

Period of Performance/Funding:

FY 79	FY 80
-0-	50K

EPA Project Officer:

James Stemmle
Office of Environmental Processes and Effects Research
RD-682
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Principal Investigators:

John M. Miller
NOAA/ERL/ARL
8060 13th Street
Silver Spring, MD 20910
(301) 427-7645

Research Objectives and Project Description:

Objectives:

1) Determine how far acidic materials are transported from their sources to final deposition; 2) establish what fractions of acidic materials are transported beyond local source areas.

Description:

Five precipitation chemistry/acid rain sites will be established to monitor acidity levels in remote areas. Candidate sites are in Alaska, Colorado, Amsterdam Island, South America, Australia, and other areas. The establishment of these sites requires contacting cooperative groups; shipping collectors, pH meters, and other equipment; and inspecting candidate sites. Provisions for field manuals and quality assurance will also be made. By the end of FY 80, some preliminary data evaluation including field measurements of pH and conductivity and laboratory analysis of returned samples will begin.

Expected Output:

Precipitation chemistry levels from remote collecting sites will be published in report form. These values will establish the background concentration of chemicals in precipitation and help establish how far acid rain has spread globally.

Milestones/Delivery Dates:

Annual report on precipitation, August 1980.

Annual report on precipitation, August 1981.

Final Report on precipitation chemistry, August 1982.

Project Title:
Dry Deposition Studies

Code:
MT 7

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
105K	95K

EPA Project Officer:
Jack Durham
Environmental Sciences Research Laboratory
MD-57
Research Triangle Park, NC 27711
(919) 541-2183

Principal Investigation:
Bruce Hicks
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
(312) 972-5792

Research Objectives and Project Description:

Objectives:
To parameterize pollutant aerosol and gas velocities of deposition to natural surfaces in terms of stability class, surface roughness, and other factors for natural surfaces, and to develop dry deposition monitors for chemical species related to terrestrial and aqueous systems acidification.

Description:
ANL will perform field investigations as part of the Northeast Regional Oxidant Study in a rural North Carolina forest and in rural Illinois to measure the dry deposition fluxes of ozone, nitrogen dioxide, sulfur dioxide, sulfate, and aerosols. The methods to be used include eddy correlation, eddy accumulation, variance, modified Bowen ratio, or concentration profile.

Expected Output:
Reports on the deposition rates of pollutant aid gases and aerosols to natural surfaces.

Milestones/Delivery Dates:
Initiate FY 80 agreement, June 1980.

Participate in Northeast Regional Oxidant Study; journal article "Some Direct Measurements of Atmospheric Sulfur Fluxes over a Pine Plantation," August 1980.

Field study: calibrate north central forest site, September 1980.

Journal article: "Particle Fluxes in Discrete Size Ranges to Pasture Grass"; journal article: "Aerosol and Gas Deposition to Farmland," November 1980.

Journal articles: "Dry Flux of O_3—NEROS," July 1981.

Project Title:
Test Dry Deposition Monitors and Techniques for Aerosols and Gases

Code:
MT 8

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
-0-	25K

EPA Project Officer and Principal Investigator:
Jack L. Durham
Environmental Sciences Research Laboratory
Research Triangle Park, NC 27711
(919) 541-2183

Research Objectives and Project Description:

Objectives:
To test the performance of some techniques purported to monitor dry deposition of acid gases and aerosols to natural surfaces. The tests are to be conducted at a site currently being used to monitor air quality and dry/wet deposition (by the Aerochem sampler). The techniques to

be tested at this site are Teflon plates and quartz fiber mats for aerosol dry deposition, foliar wash for aerosol and acid gas dry deposition, and the variance technique for ozone dry deposition.

Description:
A contract will be awarded in summer, 1980 for this investigation. A sampling and analysis protocol will be prepared for the use of Teflon plates, PbO_2 plates, fiber mats, and foliar wash that includes location and number of samplers and period of sampling events to permit the measurement of dry deposition. Also, a protocol will be prepared for the measurement of ozone dry deposition by the variance method. These devices will be operated for a period of 12 months to obtain dry deposition measurements at an air quality monitoring station.

Expected Output:

Report on test results of deposition of sulfate measured or inferred by the various methods mentioned above.

Milestones/Delivery Dates:

Award of contract, July 1980.

Monthly progress reports, August 1980.

Final report on test results, June 1981.

Project Title:
Operation of Dichotomous Sampler at MAP3S Site

Code:
MT 9

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
10K	4K

EPA Project Officer:
Robert Stevens
Environmental Sciences Research Laboratory
Research Triangle Park, NC 27711
(919) 541-3156

Principal Investigator:
James Galloway
Department of Environmental Sciences
University of Virginia
Charlottesville, VA 22903
(804) 924-7761

Research Objectives and Project Description:

Objectives:
Determine the relationship of aerosol acidity to wet and dry deposition measurements. Compare the relative contribution of acidity from aerosols with wet deposition.

Description:
Operate Beckman automated dichotomous samplers at MAP3S site near the University of Virginia. Collect aerosols and return filters to EPA in special NH_3-free containers for mass, XRF, H^+, $SO_4^=$, NO_3^- and NH_4^+ analysis. Data from these studies will be combined into reports related to acid deposition studies.

Expected Output:

Reports describing composition of aerosol compared to wet deposition measurements. Data will include frequency of acid aerosol events and their magnitude.

Milestone/Delivery Date:

Report on first year's aerosol measurements compared to wet deposition studies, June 1981.

Project Title:
MAP3S Program Direction

Code:
AP 1.1

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
118K (39K)*	118K (78K)*

EPA Project Officer:
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Office of Environmental Processes
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Principal Investigator:
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Battelle Pacific Northwest Laboratories
PO Box 999
Richland, WA 99352
(509) 375-7990

Research Objectives and Project Description:

Objective:
Direction of the multi-laboratory MAP3S Program, whose major objective is to define the relationships between the emissions of air pollutants, their deposition, and the chemical quality of precipitation.

Description:
The MAP3S program director functions as a coordinator of research activities, as a primary representative of MAP3S to EPA and to the outside research community, and as a chairperson of steering and liaison committees dealing with policy and research emphasis.

The director selects steering and liaison committees with the advice and consent of EPA and the major participating laboratories. He coordinates creation of the program-design document for MAP3S, which serves as an extended research and planning guide.

The director also utilizes his limited program funds to encourage specific research activities in needed areas, to bring consultants into the program when needed, and to fulfill additional directorship functions on an as-needed basis.

MilestonesDelivery Dates:

MAP3S steering committee selected October 1, 1979.

MAP3S liaison committee selected January 1, 1980.

Precipitation chemistry collectors purchased March 1, 1980.

MAP3S design document finalized March 1, 1980.

President's Acid Rain Assessment Plan drafted March 1, 1980.

MAP3S status paper presented June 1, 1980.

Network objective analysis funded (ANL) August 1, 1980.

*Money considered as acid rain research.

Project Title:
MAP3S Modeling Studies

Code:
AP 1.2

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
165K (63K)*	190K(126)*

EPA Project Officer:
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Principal Investigators:
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Research Objectives and Project Description:

Objective:
The objective of the MAP3S Modeling Studies is to develop computer models that will simulate the behavior of the atmosphere and its contaminants from the sources to the receptors in the various regions of interest, with special emphasis on the fate of sulfur compounds in the northeastern United States. The results from this work will aid EPA in assessing the impacts of the long-range transport of SO_2 and sulfates, oxides of nitrogen, and the severity of acid precipitation from pollutant emissions.

Description:
The modeling studies consist of three modes: model development, model testing and application, and support of experimental programs. The principal models being developed are those that treat transport, dispersion, transformation, and removal mechanisms for parcels of pollutants in a Lagrangian coordinate system, although examination of grid type models, as an aid to Lagrangian model development, is being pursued in FY 79 and FY 80. The trajectory models being considered are a long-term, source-oriented, forward-trajectory model for assessment and a short-term, receptor-oriented model.

Model testing is being performed using the formulated trajectory models on data from four time periods: April 1974, August 1977, October 1977, and July 1978. The first case is the initial reference case for the project and the last three cases are the intensive study periods of the EPRI SURE (Sulfate Regional Experiment) Program. Since the MAP3S field experiments are being conducted to gain insight and information that is needed in the simulation effort, the models have been put to use where possible to aid in the planning of experiments and in data analysis.

Model documentation is being prepared to simplify model use by other investigators and model testing is being carried out in a cooperative program with Argonne and Brookhaven National Laboratories.

Expected Output:

The program will provide a series of models capable of investigating problems with long-range pollution transport and acid species deposition.

Milestones/Delivery Dates:

Model Testing Publications, September 1979.

Interlaboratory Model Testing, June 1980

Documentation on Long-Range Pollution Transport Models, September 1980.

*Money considered as acid rain research.

Project Title:
Precipitation Scavenging

Code:
AP 1.3

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
340K	340K

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objectives:
The overall program objectives are to determine the dominant scavenging mechanisms for a variety of pollutants and to develop an improved capability to predict the wet removal of pollutants by clouds and precipitation.

Description:
Field studies represent a major program component and are concerned with obtaining measurements for computing pollutant removal. Attempts will be made to relate the scavenging to storm intensity, ice- and cloud-water content, precipitation rate and to pollutant mass flux into the storm. Microphysical models will be developed in order to generalize removal and transformation predictions to a variety of synoptic systems.

Regional-scale wet removal of pollutants will be investigated with the aid of precipitation chemistry data from the MAP3S Precipitation Chemistry Network. Attempts will be made to relate the meteorological conditions to the concentration of pollutants in the precipitation.

Expected Output:

The work will be divided among the three research tasks and the one program management task.

Descriptions of each task follow.

Task 1: Historical Data Analysis: This task will involve the continued reduction and interpretation of the field data obtained from winter storms in Michigan. Reduction of magnetic tape data, ice crystal replicas, radar film, analog output, and chemical analysis of all precipitation samples should be completed by spring of 1980.

Attempts will be made to define sulfate and nitrate removal for the specific events encountered in the experiments. Also of special interest is any data which might help resolve the pH dilemma (i.e., Where does the acid come from?).

Specific subtasks include:

- Interpretation of meteorological and precipitation chemistry data, specifically, radar film, ice crystal replicas, and impactor data.
- Determination of aerosol size, mass, and CCN supersaturation spectra.
- Determination of cloud-liquid water content, cloud-water chemistry, and droplet size distribution.
- Evaluation of cloud liquid water sampler.
- Identification of pollutant source regions for each event sampled in the field. Involves construction of diabatic back trajectories.
- Generalization of data, model formulation and testing.

Task 2: Regional-Scale Data Interpretation: Precipitation chemistry data obtained from the MAP3S Precipitation Chemistry Network and from the two experimental periods in Michigan and Illinois will be examined to see if relationships between precipitation chemistry and meteorological conditions can be identified.

Specific subtasks include:

- Determination of the age of the air mass being scavenged.
- Determination of air residence time in clouds.
- Identification of time between storms Lagrangian and Eulerian. (Preparation of frequency diagram.)
- Measurement of duration of storms, frequency intensity diagrams.

Task 3: Experimental Design Task: The work assigned to this area is concerned with designing and performing field experiments which will yield reliable data for determining in-cloud chemical transformation rates. Data must also be acquired to test and refine current parameterizations involving surface deposition by precipitation.

Because of the difficulty of separating transformation products from the natural background products, no single, simple experimental design has been judged to be adequate for investigating in-cloud transformation.

The work performed in this task will involve several simple pilot studies designed to test measurement capabilities and to provide gross upper and lower bounds for transformation rates. The cloud systems will be restricted to simple, nonprecipitating convective and stratiform clouds.

A major prerequisite for the pilot studies is successful development and testing of a cloud-liquid water collector. Flight testing of two potential candidates will be conducted during January and February 1980.

Inter-laboratory collaboration is essential for successful completion of this task. The cooperation is necessary to assure beneficial experiment design and to assist in acquiring samples in the vicinity of cloud systems.

Specific subtasks include:

- Experiment planning meeting at Jekyll Island.
- Cloud-water collectors test flights.
- Literature review of cloud streets, rolls.
- Pilot studies on warm cloud systems.

Task 4: Project Management: This task includes all the management efforts related to organizing field trips, project scheduling, personnel involvement, and report writing.

At least two reports are anticipated. One report should summarize the data collected in the experimental studies, and the other report should present the parameterization schemes developed during the course of this program. These reports will be submitted as journal publications in scientific journals.

Project Title:
Laboratory Research in MAP3S

Code:
AP 1.4

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
188K (63K)*	188K (126K)*

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objective:

Task 1: Develop advanced pollution monitoring equipment for airborne application to scavenging field experiments.

Task 2: Define and quantify the role of organic nitrogen compounds as they influence precipitation chemistry.

Task 3: Quantify rate phenomena associated with aqueous phase conversion processes in cloud and precipitation water.

Description:

Task 1: This task has two essential components. The first of these is the continual maintenance of equipment for field usage under a formal quality-assurance program. This component is also used for upgrading QA procedures in specific areas, such as the creation of new QA-oriented data acquisition software, and development of advanced calibration techniques.

The second component of development of special airborne equipment for field application in scavenging experiments. An advanced $NO/NO_x/NH_3/HNO_3$ analyzer,

an altitude-independent SO_2 monitor, and cloud-water collectors are currently in late stages of development in this project.

Task 2: This task will use three approaches. The first of these is a speciation study which will identify the amounts and types of organic nitrogen compounds existing in precipitation samples collected on the MAP3S/RAINE network. This will begin at a modest level using micro-Kjeldahl procedures for total organic nitrogen in precipitation; depending on these results, more elaborate speciation studies may be conducted using gas chromatography or GC-MS.

The second approach used in this research is to conduct solubility measurements for the NH_3-CO_2 system. These measurements will be an extension of those described recently by Hales and Drewes (1979), and will be directed toward elucidating the mechanism and extent of the $CO_2 + NH_3$ interaction, and deriving a reliable means of solubility prediction. This information will be supplied to MAP3S/RAINE modeling components for the purpose of formulating improved scavenging rate expressions.

The third approach used in this component will pursue the importance of peroxyacetylnitrate (PAN) in precipitation. Specifically, the investigation will attempt to determine the solubility of this important photochemically formed species, and identify the species formed in the aqueous phase as a result of the dissolution of PAN.

Task 3: The significant feature of this task will be the use of precipitation samples and ambient air to simulate in-cloud conditions. Rainwater samples, collected at MAP3S Precipitation Chemistry sites, will be examined using standard analytical procedures to establish the concentration of prominent anionic and cationic species and NAA to quantitatively identify trace metals capable of catalytic activity. The cloud-water reactor assembly will consist of a thermostated glass vessel used to hold a rainwater sample of known composition. A stream of ambient air will be passed through the reactor to simulate atmospheric circulation which brings cloud-water into contact with trace gases such as ozone and hydrogen peroxide. Multiple experiments will be performed to assess the effect of temperature on compositional changes accompanying exposure to both filtered and unfiltered air.

These experiments will be conducted in parallel with continuous monitoring of the ambient atmosphere to provide real-time profiles of several trace gases and integrated measurement of hydrogen peroxide and aerosols. Changes in the composition of the rainwater will be followed by periodic removal of aliquots for analysis. The resulting data will be subjected to a statistical analysis to determine the correlation between atmospheric parameters and observed sulfate and nitrate production rates.

Expected Output and Milestones:

Task 1:

Inlet System constructed and operating December 1, 1979.

NO/NO_x analyzer constructed and operating January 1, 1980.

Cloud-water sampler tested and operating February 1, 1980.

High-volume air sampler testing and calibrating completed March 1, 1980.

Aircraft data acquisition system updating completed April 1, 1980.

Extend NO_x instrument to $HNO_3$and NH_3 November 1, 1980.

Begin instrument development for other species (H_2O_2, PAN) December 1, 1980

Begin to develop real-time sulfate measurement January 1, 1980.

Task 2:

Begin micro-Kjeldahl analysis of MAP3S/RAINE samples October 1, 1980.

NH_3 solubility apparatus designed December 1, 1980.

PAN solubility apparatus designed February 1, 1980.

NH_3 solubility apparatus constructed and operating April 1, 1980.

Begin PAN solubility measurements July 1, 1980.

Implement GC speciation studies (if advisable) November 1, 1980.

Begin PAN speciation studies in aqueous January 1, 1981.

NH_3 solubility measurements completed; mechanism formulated and quantified March 1, 1981.

PAN solubility and speciation studies completed June 1, 1981.

Possible application of solubility apparatus to additional compounds September 1, 1981.

Task 3:

Initial rainwater samples collected and analyses completed February 1, 1980.

Air quality instrumentation in place and relocation vessel operational. Experimental series begins at clean-air site March 1, 1980.

First series of experiments ends and statistical analysis completed September 1, 1980.

Second series of experiments begin at site characterized by reduced air quality January 1, 1981.

Analysis of data from second test series completed August 1, 1981.

Initial parameterizations of NO_x and SO_x conversion rates completed and delivered to modeling community September 1, 1981.

*Money considered as acid rain research.

*Money considered as acid rain research.

Project Title:
Chemical Characterization of Aerosols

Code:
AP 1.5

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
88K (10K)*	88K (25K)*

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objective:
To sample and analyze the fine particulate atmospheric aerosol at several nonurban locations distributed across the northeastern U.S. In particular, to measure the atmospheric particulate loading and sulfate acidity of the submicron particles.

Description:
Using a modified Lundgren cascade impactor, time- and size-resolved samples of atmospheric aerosol are being obtained at five selected locations: College Town, Pennsylvania; Charlottesville, Virginia; Rockport, Indiana; Upton, New York; and Raquett Lake, New York. The 0.3 to 1.0 and the 1.0 to 3.0 micrometer size fractions are analyzed for ammonium sulfate, nitrate, and acidity using Fourier transformation infrared spectroscopy.

Results obtained to date have shown that the fine particulate aerosol acidity is much greater in the eastern U.S. than in the Midwest, but aerosol loading is much greater in the Midwest than in the East. Aerosol acidity and loading both reach their highest values during the summer months. Distinct diurnal variations have been observed in both acidity and loading at all sampling sites. These diurnal cycles vary with season.

Expected Output:

Part of MAP3S program. See projects AP 1.1 and AP 1.2.

*Money considered as acid rain research.

Project Title:
Boundary Layer Investigations

Code:
AP 1.6

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
413K (40K)*	403K (75K)*

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objectives:
To develop procedures for simulating the transport and dispersion of pollutants in the lower atmosphere, including their incorporation in clouds and the precipitation process.

To improve methods for parameterizing the deposition of pollutants at the earth's surface, with emphasis on acidic species.

To develop improved, regional-scale numerical models of the deposition of chemical species, again with emphasis on acidic species.

Description:
Experimental field studies supported by laboratory and theoretical investigations are conducted to develop improved parameterizations of dispersion, transport and deposition processes for inclusion in regional atmospheric deposition models. Wherever possible, field experiments are conducted in collaboration with intensive studies of air and precipitation chemistry. Detailed studies of dry and wet deposition are made in intensive dedicated experiments designed to address specific questions of importance to modeling efforts at this and other laboratories.

As a result of extensive field investigations of the dry deposition of atmospheric pollutants to natural surfaces, a map of deposition velocities appropriate to various terrain types, seasons of the year, and stability conditions has been produced for the MAP3S region. An "Advanced Statistical Trajectory Regional Air Pollution" (ASTRAP) model has been developed and applied to evaluate pollutant fluxes across the U.S./Canada border. During 1979, detailed dispersion investigations were carried out as part of the Central Illinois Rainfall Chemistry Experiment (CIRCE), including field tests of new methods for evaluating flow into convective cells by remote lidar and sodar techniques.

Expected Output:

Part of MAP3S program. See projects AP 1.1 and AP 1.2.

*Money considered as acid rain research.

Project Title:
Transport and Transformation

Code:
AP 1.7

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
415K (130K)*	415 (260K)*

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objective:
As part of the Multistate Power Production Pollution Study (MAP3S), this project is aimed at improving the capability of predicting the atmospheric effects of emissions from fossil-fueled power plants. This specific project has as its objective the collection of field data to guide the development of, and to test, regional-scale air quality models.

Description:
Measurements are made to characterize existing air quality in the northeastern United States and to investigate atmospheric processes that are important in the regional-scale transport and transformation of air pollutants.

The characterization measurements emphasize concentrations above the surface and are made from aircraft.

Pollutants routinely measured are SO_2, $SO_4^=$, NO, NO_2, and light-scattering particulates; meteorological measurements include temperature, relative humidity, solar radiation and turbulence. Wind speed and direction are calculated from navigational measurements. The characterization experiments have been done in conjunction with intensive ground-based measurements conducted in the SURE program sponsored by EPRI. Current efforts are focused on data interpretation and analysis.

Process-oriented experiments have been aimed at chemical transformation and at mechanisms leading to long-range transport. The former have emphasized studies of power plant plumes. The latter examined processes that mix pollutants to higher altitudes by making vertical profile measurements under various meteorological regimes.

Current efforts are in the analysis of past experiments and in developing methodologies for use in clouds and in precipitation systems so that the chemical composition of rain may be investigated.

Expected Outputs:

Part of MAP3S program. See projects AP 1.1 and AP 1.2.

*Money considered as acid rain research.

Project Title:
MAP3S Central Data Coordination

Code:
AP 1.8

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
155K (50K)*	155K (100K)*

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objectives:
The wide variety of data generated by and needed for the MAP3S program clearly indicates the need to centralize the coordinating function. This central facility collects, archives and disseminates the appropriate experimental data generated by MAP3S and collaborating programs and the auxiliary data needed by MAP3S program participants.

Merging of disparate data into working data sets will be accomplished once and will allow researchers access to desired information from one central location. Periodic reports are to be generated containing graphical and tabular displays of available data. User requests for data will be handled in a timely fashion. Direct user access to data and computational techniques could also be provided.

Description:

This research will be divided into the following tasks:

Task 1: Development and implementation of format and methodologies needed to produce periodic reports with tabular and graphical displays of available data. Development and implementation of procedures needed to process user requests for data in a timely fashion and to allow direct user access to data and data handling techniques.

Task 2: The source emissions inventory developed during MAP3S Phase I will be maintained and periodically updated. Data in the inventory will be studied and upgraded where needed. Geographic coverage will be extended to encompass all of the continental U.S. and eventually all of Canada. User-oriented procedures will be developed to generate gridded data suitable for modeling studies.

Task 3: Creation of an integrated data set for air quality and precipitation chemistry data. These data will be obtained from diverse sources such as the SURE ground-station network, EPA's National Aerometric Data Bank (NADB), MAP3S precipitation chemistry network, etc. The merging process requires careful study and evaluation to ensure correct interpretation of all data elements since data handling procedures for all these sources have been created independently. Additional types and/or sources of data could be added as research progresses.

Expected Output:

Part of MAP3S program. See projects AP 1.1 and AP 1.2.

*Money considered as acid rain research.

Project Title:
Aircraft Operations

Code:
AP 1.9

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
191K (50K)	191K (100K)

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objective:

Task 1 - Equip and maintain an atmospheric research aircraft for pollution studies.

Task 2 - Develop or improve pollution measurement methods for airborne applications.

Task 3 - Conduct field measurements.

Description:

Task 1: A twin-engine Brittin-Norman Islander was obtained on an exclusive-use lease for use as an Atmospheric Pollution Research Aircraft. An equipment package was designed and installed in the aircraft for the measurement of pollution, meteorological, and navigational parameters. Gaseous pollutants such as SO_2, NO_x, and O_3 are measured in real time. Integrated samples of SO_2 and $SO_4^=$ are also collected. Important meteorological parameters such as temperature, dew point, and solar radiation, as well as position-fixing navigational measurements are also made in real time. The fully equipped aircraft was operational in late July 1977.

Task 2: Pollutant measurement instruments are generally not designed for airborne applications, necessitating modification of many instruments prior to use on aircraft. In addition, requirements for new measurement techniques based on program requirements have yielded new state-of-the-art methods. A modified condensation nuclei counter with a diffusion battery size-separation system which allows the measurement of suboptical size distribution of ambient aerosols has been developed and installed in the BNL aircraft. A four-size-step aerosol sampling system has been developed and installed. The modification of a commercial FPD sulfur analyzer to eliminate altitude sensitivity has been undertaken. The development of a fast response NO_x monitor is planned for 1980-1981.

Task 3: Since August 1977 the BNL Atmospheric Sciences Aircraft has operated in several multi-laboratory intensive field studies and in many individual efforts. Pollutant distributions in the horizontal and vertical have been a major effort.

Expected Output:

Part of MAP3S program. See projects AP 1.1 and AP 1.2.

*Money considered as acid rain research.

Project Title:
Modeling and Analysis

Code:
AP 1.10

Funding Program:
MAP3S/RAINE

Period of Performance/Funding:

FY 79	FY 80
165K (55K)	165K (110K)*

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Principal Investigator:
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Research Objectives and Project Description:

Objectives:
Develop and verify advanced regional (multi-state) scale air quality models treating nonlinear chemistry (SO_x, O_3, NO_x, etc.) capable of providing air quality analysis.

Description:
The approach is to develop an Eulerian grid numerical model using advanced numerical methods to solve the stiff sets of chemical reactions and transport; diagnostic meteorological models (and support prognostic model development) using observations, physical constraint equations, and terrain data to supply meteorological data for the air quality model; probability equations to understand the effects of mixing on chemical reactions; and a computer link from BNL to the National Weather Service, Suitland, MD (NWS), to acquire timely meteorological data.

The project includes development of more accurate and more efficient numerical techniques (currently being tested in 2D form) using modern homogeneous-heterogeneous chemistry surrogate mechanisms; the link to NWS is operational and computer programs are to be developed to interface data with models. The diagnostic meteorological models are partially developed and are being used to analyze meteorological data. Theorems prescribing the evolution of the probability density functions of concentrations have been developed.

Expected Output:

Part of the MAP3S program. See projects AP 1.1 and AP 1.2.

*Money considered as acid rain research.

Project Title:

Precipitation Scavenging of Pollutants

Code:

AP 2

Funding Program:

Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
78K	85K

EPA Project Officer:

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(919) 541-4541

Principal Investigator:

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Research Objectives and Project Description:

Objectives:
The objective of the study is to model, theoretically and experimentally, the scavenging of particulate and gaseous pollutants by cloud and precipitation elements.

Description:
Theoretical mathematical models will be developed for the scavenging of aerosols by ice crystals complementing previous work done for the scavenging of aerosols by raindrops. The theoretical formulation and predictions will be experimentally tested in UCLA rainshaft and the UCLA cloud tunnel.

The second phase of the study is the development and testing of models describing the scavenging of gases by cloud and raindrops, with primary emphasis on SO_2. The rainshaft will be modified to allow drops at terminal velocity to fall through a chamber containing varying concentrations of a pollutant gas.

The work done on the grant during the first eighteen months (October 1978 through March 1980) consisted of completion of a study of the scavenging of aerosols by ice crystals; formulation of a theory for the scavenging of SO_2 by cloud and small raindrops; and initiation of laboratory experiments in the rainshaft to study the scavenging of SO_2 and to test the theoretical predictions. The results of the studies of the scavenging of aerosols by water drops and ice crystals are being published in five journal articles.

Expected Output:

Mathematical models for the scavenging efficiency of gas by cloud and raindrops and of aerosols by ice crystals.

Milestones/Delivery Dates:

Journal articles on the scavenging of aerosols by precipitation elements, October 1980.

Journal article on the scavenging of gases by cloud and raindrops, October 1981.

Project Title:
Refinement, Verification, and Application of a Long-Range Transport Model of SO_2 and Sulfate.

Code:
AP 3

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
60K	75K

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objectives:
To improve upon the model that has been developed previously (EPA-600/4-79-068) and to add an algorithm for acidity of precipitation. Currently, the model calculates dispersion, SO_2 transformation to $SO_4^=$, SO_2 and $SO_4^=$ dry and wet deposition, and SO_2 layers along plume trajectories from major SO_2 sources. Anticipated improvements to the model include (1) optimizing computer program to save running time and improve program descriptions of transport, mixing height, and precipitation physics; (2) verifying model output with observed data; (3) developing a method for specifying acidity of precipitation; and (4) applying to model using projected emissions.

Description:
Literature is used to develop model physics and chemistry as well as necessary empirical relationships. EPA temperatures aloft are used to run the model. Measurements of pollutants are used for verification of the model results.

Expected Output:
Validated model capable of estimating the regional-scale distribution of airborne SO_2 and $SO_4^=$, dry and wet deposition, and acidity of precipitation.

Milestones/Delivery Dates:
Progress Report, March 1980.
Project Report and Project Summary, December 1980.

Project Title:
Precipitation Chemistry Field Program

Code:
AP 4

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
25K	25K

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objectives:
To estimate the pollutant scavenging efficiency of convective and frontal storms.

Description:
The purpose of this study is to collect and analyze precipitation samples, and to determine the scavenging efficiency of precipitation from convective and frontal clouds.

The precipitation samples will be collected using a sequential sampler, the pH measured, and the samples analyzed for various organic and inorganic species. The resulting data base will be used to estimate the removal rate of pollutants by precipitation.

A sequential precipitation sampling system was developed and is in use. A second sampling station is under construction. The system is described in a published EPA report.

Expected Output:

Report on the scavenging efficiency of precipitation from convective and frontal clouds.

Milestones/Delivery Dates:

Progress Report, September 1978.

EPA report (EPA-600/4-80-004) on the Chemistry of Precipitation from sequentially sampled storms, January 1980.

Progress Report, December 1980.

EPA report on the field study of the scavenging efficiency of precipitation, December 1981.

Project Title:
Adaptation of EURMAP Model for Eastern U.S.

Code:
AP 5

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
69K	50K

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objectives:

- To adapt, refine, and apply the EURMAP model to the eastern U.S. to estimate monthly, seasonally, and annually averaged concentrations, wet and dry depositions, and regional contributions to the depositions of SO_2 and $SO_4^=$.
- To define a trend in SO_2 and $SO_4^=$ regional concentrations and depositions over the period 1930-2000.

Description:

The EURMAP-1 model developed by SRI, International, in fulfillment of a contract with the Federal Environmental Agency of the Federal Republic of Germany, is to be adapted to the eastern two-thirds of the U.S. and southern Canada. The adapted version of the model is to be applied to this region using available meteorological data (upper-air winds and precipitation amounts) for 1975-1978; Sulfate Regional Experiment (SURE) and National Emissions Data System (NEDS) emissions data for 1977; and SURE and Storage and Retrieval of Aerometric Data (SAROAD) air quality data for 1978. In addition, the model is to be applied to the same region using the following scenarios:

- 1977 meteorological data and 1985 projected SO_2 emissions;
- A "worst case" meteorological scenario and 1985, 1990, 1995, and 2000 projected SO_2 emissions;
- A meteorological scenario defined by the ten-year average meteorological data (1934 to 1957) and 1930 and 1940 estimated SO_2 emissions; and
- Meteorological data and estimated SO_2 emissions data for 1950, 1955, 1960, and 1972.

Expected Output:

For 1930, 1940, 1950, 1955, 1960, 1972 on an annual basis and for 1975-1978, 1985, 1990, 1995, and 2000 on a seasonal and annual basis, the following output are to be expected:

- SO_2 and $SO_4^=$ concentrations
- SO_2 and $SO_4^=$ wet and dry depositions
- interregional impacts on SO_2 and $SO_4^=$ depositions for
  - a) Region I
  - b) Region II
  - c) Region III
  - d) Region IV -North
  - e) Region IV - South
  - f) Region V - North
  - g) Region V - South
  - h) Region VI - East
  - i) Region VII
  - j) Region VIII - Northeast
  - k) Region VIII - Southeast
  - l) Southern Quebec
  - m) Southern Ontario

Milestones/Delivery Dates:

Presentation of 1977 modeling results at the Second Joint AMS/APCA Conference on Air Pollution Meteorology, March 1980.

Delivery of report summarizing the model adaptation effort and containing 1977 and 1985 modeling results and analyses, April 1980.

Delivery of report containing 1975, 1976, and 1978 modeling results and analyses, September 1980.

Delivery of report containing 1985, 1990, 1995, and 2000 modeling results and analyses, December 1980.

Project Title:
Acid Rain Program Support

Code:
PS 1

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
45K	94K

EPA Project Officer:
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Principal Investigator:
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Research Objectives and Project Description:

Objectives:
Assist EPA's Anticipatory Research Program in a variety of tasks which will help develop and focus the agency's Atmospheric Acid Deposition Program.

Description:
- Perform a preliminary analysis of the acidity associated with dews, fogs, and frosts. This will include a summation of all research previously performed in the area along with theoretical development of the problem. In addition, a rough cut at the frequency distribution of dew, fogs, and frosts will also be estimated.
- Develop and publish a quarterly status report (newsletter) on the activities of the EPA Acid Deposition Research Program. Status report to be published quarterly during April, July, October, and January.
- Develop a summation of all EPA acid rain projects being funded during FY 79-80. This will include publication of the summary along with incorporation into computerized data banks.
- Provide additional miscellaneous support: incorporate the reviews of the Five-Year Plan into a final product; host 1-2 information exchange meetings at MITRE with resultant documentation of the meetings; assist in putting together briefings, etc.

Expected Output:

Publication of results in MITRE and EPA reports and in technical journals. Presentations at various meetings and conferences and quarterly newsletter publication and distribution.

Milestones/Delivery Dates:

Quarterly Status Report Publication, April-July-October 1980.

Project Summaries Report, June 1980.

Summation of Dews, Fogs, and Frosts Report, June 1980.

Finalization of Five-Year Plan, August 1980.

Project Title:
Acid Rain Program Support

Code:
PS 2

Funding Program:
Anticipatory Research Program

Period of Performance/Funding:

FY 79	FY 80
55K	70K

EPA Project Officer:
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Research Objectives and Project Description:

Objective:
To assist EPA's Anticipatory Research Program in a variety of tasks in a general program support role.

Description:

- Based on the monitoring report proposed to EPA and other agency monitoring reports, Teknekron will prepare a chapter of the president's Federal Acid Rain Monitoring Plan. Teknekron will further examine the criteria desired for determining what types of monitoring should be done for acid rain based on the needs of all participating federal agencies. Teknekron will work with the Council on Environmental Quality, the Federal Interagency Subcommittee and EPA to first develop and then revise this part of the president's plan.
- Teknekron will document the locations, sampling methods, analytical procedures, quality control procedures, and results of all acid rain monitoring stations operated over the last five to 30 years in the U.S. (Canadian data to be included if readily available.) The contractor will assemble the results of this survey in one document and identify key trends and changes in monitoring station results. All monitoring data for representative years will be included in the contractor's report.
- Teknekron will update the sensitivity map of the U.S. produced under a previous task order. It will utilize state and local maps of soils and geological conditions developed by EPA's Corvallis, Oregon, laboratory and other sources to assemble a composite picture of areas sensitive to acid rains.

Expected Output:

Publication of results in Teknekron and EPA reports.

Presentations at various meetings and conferences.

Milestones/Delivery Dates:

Initial draft of monitoring chapter for the President's Federal Acid Rain Plan, March 1980.

Literature survey of monitoring activities, September 1980.

Sensitivity map update, September 1980.

Environmental Effects:

Agriculture

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EE 1.0	3	EE 3	11
EE 1.1	4	EE 4	12
EE 1.2	4	EE 9	17
EE 1.4	5	EE 10	18
EE 2	11	EE 12	20

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EE 1.5	6	EE 16	24
EE 1.7	7	EE 17	25
EE 1.12	9	EE 19	26
EE 1.13	10	EE 20	27
EE 1.14	10	EE 21	28
EE 2	11		
EE 11	19	EE 22	28
EE 13	21	EE 24	30
EE 14	22		

Drinking and Groundwater

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Forests

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EE 1.1	4	EE 8	16
EE 1.11	9	EE 9	17
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EE 3	11		

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EE 1.10	8	EE 14	22
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Monitoring:

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Dry Deposition

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MT 3	34		

Atmospheric Processes:

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AP 1.3	43	AP 2	51
AP 1.4	44	AP 4	52
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Transport

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Program Support:

Code	Page	Code	Page
PS 1	55	PS 2	55

EPA Laboratories

- Environmental Monitoring Systems Laboratory, RTP.
  MT 1, MT 3
- Environmental Research Laboratory, Corvallis.
  EE 3, EE 4, EE 5, EE 6, MT 5
- Environmental Research Laboratory, Duluth.
  EE 13, EE 14, EE 19, EE 23
- Environmental Science Research Laboratory, RTP.
  MT 8
- Municipal Environmental Research Laboratory, Cincinnati.
  EE 24

Academic Institutions

- Butler University
  EE 1.3, EE 7
- Colorado State University
  AP 3
- Cornell University
  EE 1.2, EE 1.9, EE 16
- Dartmouth College
  EE 1.8
- Michigan State University
  EE 1.7
- North Carolina State University
  EE 1.0, EE 1.1
- New York State Agricultural Experiment Station
  EE 1.4
- New York University
  EE 1.6
- Oregon State University
  EE 2
- Pennsylvania State University
  EE 2
- Purdue University
  EE 2
- United States Military Academy
  AP 4
- University of California, Berkeley
  EE 1.10
- University of California, Los Angeles
  AP 2
- University of California, Riverside
  EE 2
- University of Florida
  EE 1.11, EE 1.13
- University of Maine
  EE 1.5
- University of Minnesota, Duluth
  EE 15, EE 20, EE 21, EE 22
- University of Virginia
  MT 9
- University of Wisconsin, Madison
  EE 17
- University of Wyoming
  EC 1
- Washington University, St. Louis
  EE 25

Governmental Agencies/Laboratories

- Argonne National Laboratory
  AP 1.5, AP 1.6, EE 10, MT 7
- Battelle Pacific Nortwest Laboratory
  AP 1.1, AP 1.2, AP 1.3, AP 1.4, MT 4
- Brookhaven National Laboratory
  AP 1.7, AP 1.8, AP 1.9, AP 1.10, EE 2, EE 9
- Freshwater Institute, Winnipeg, Canada
  EE 1.12
- National Oceanographic and Atmospheric Administration.
  MT 6
- Norwegian Institute for Water Research
  EE 1.14
- Oak Ridge National Laboratory
  EE 8, EE 12
- Tennessee Valley Authority
  EE 8
- United States Fish and Wildlife Service
  EE 11
- United States Geological Survey
  EE 18

Other Contractors

- MITRE Corporation
  EE 2, PS 1
- Rockwell International
  MT 2
- SRI International
  AP 5
- Teknekron Research, Inc.
  PS 2

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